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A.M.A. ARCHIVES OF OTOLARYNGOLOGY

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TABLE OF CONTENTS

VOLUME 68 SEPTEMBER 1958 NUMBER 3

ORIGINAL ARTICLES

PAGE

Experiences with the Osteoplastic Anterior Wall Approach to the Frontal Sinus
Robert L. Goodale, M.D., and William W. Montgomery, M.D., Boston 271

Vocal Rehabilitation of Paralytic Dysphonia
Godfrey E. Arnold, M.D., New York 284

The "Maxilla-Premaxilla" Approach to Extensive Nasal Septum Surgery
Maurice H. Cottle, M.D.; Roland M. Loring, M.D., Chicago; George F. Fischer, M.D., Wilmette, Ill., and Irwin E. Gaynon, M.D., Milwaukee 301

Histological Examination of a Case of Otosclerosis Fifteen Months After Stapes-Mobilization Operation
Franz Altmann, M.D., and Milos Basek, M.D., New York 314

Surgical Landmarks in Rhinoplasty
John A. Cinelli, M.D., New York 325

Abscess Tonsillectomy
Bertel Grahne, M.D., Helsinki, Finland 332

Basic Hearing Tests and Information They Reveal
Wallace Rubin, M.D., New Orleans 337

Atrophic Rhinitis
William H. Saunders, M.D., Columbus, Ohio 342

Retrograde Intramucosal Hump Removal in Rhinoplasty
Jack R. Anderson, M.D., and Wallace Rubin, M.D., New Orleans 346

Chronic Maxillary Sinus Disease
C. K. Miller, M.D.; L. E. Hildebrand, M.D.; M. G. Radewan, M.D.; G. W. Miller, M.D., and M. L. Westerberg, D.D.S., M.S.D., Wenatchee, Wash. 351

AUDIOLOGY SECTION

Frequency and Amplitude Modulation Audiometry
Neil Reilly, M.B., B.S., D.L.O., F.R.A.C.S., Adelaide, South Australia 363

The Use of Hearing Aids by Public School Children
Bruce M. Siegenthaler, Ph.D., University Park, Pa. 367

Correlation of Filtered, Band-Limited White Noise and the Speech Reception Threshold
Morton Zarcoff, M.S., New York 372

CASE REPORTS

Sarcoidosis of the Larynx
William M. Trible, M.D., Washington, D. C. 382

Anomalies of the Middle Ear
John F. Tolan, M.D., and Heston L. Wilson, M.D., Seattle 384

CLINICAL NOTES, NEW INSTRUMENTS AND TECHNIQUES

A Simple Quantitative Caloric Test
L. L. Titche, M.D., Tucson, Ariz. 388

PROGRESS IN OTOLARYNGOLOGY

Bronchoesophagology
F. Johnson Putney, M.D., Philadelphia 390

REGULAR DEPARTMENTS

News and Comment 389

Books 400

Directory of Otolaryngological Societies 401

A. M. A.
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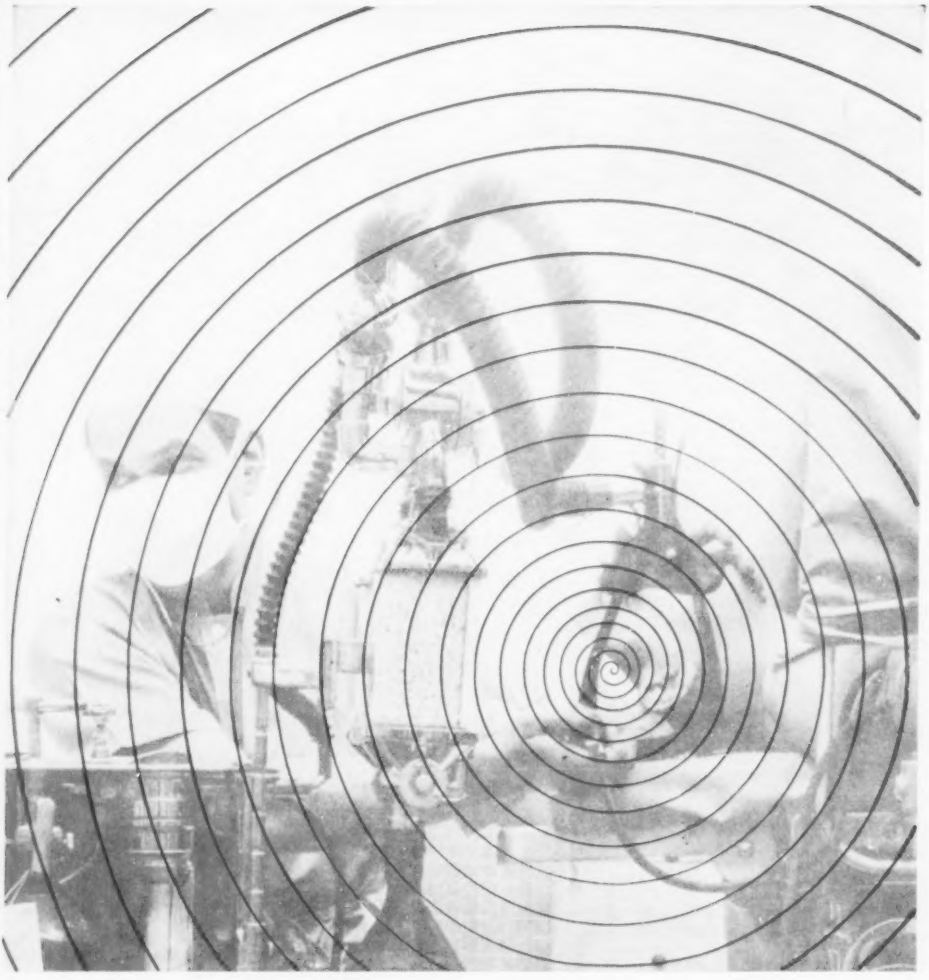

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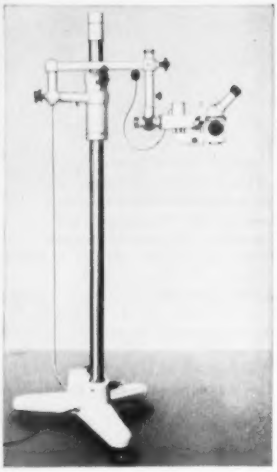

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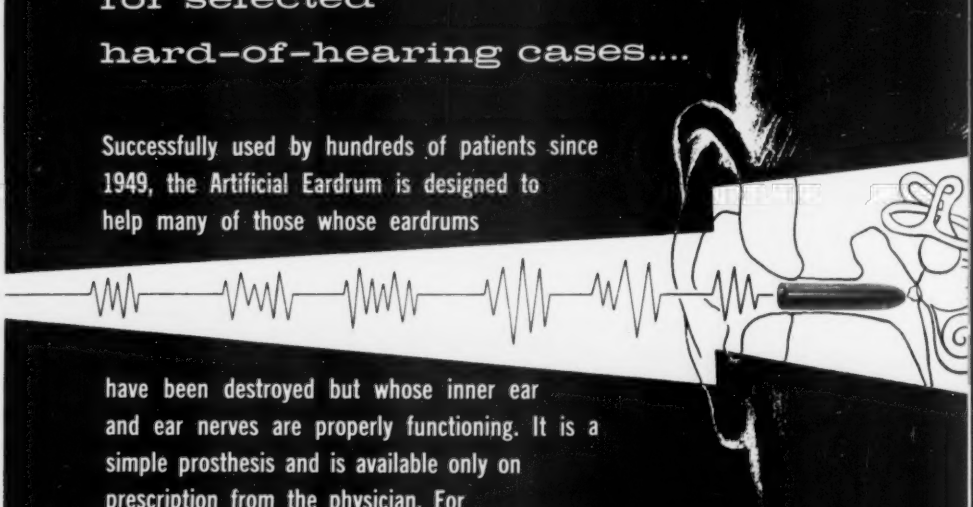

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Experiences with the Osteoplastic Anterior Wall Approach to the Frontal Sinus

Case Histories and Recommendations

ROBERT L. GOODALE, M.D., and WILLIAM W. MONTGOMERY, M.D., Boston

I

During the past two years, we have had occasion to use the anterior approach to the frontal sinus both for the obliteration of the frontal sinus and as an alternative to the Jansen-Lynch operation. The temporary reflection of the anterior bony wall of the frontal sinus with attached periosteum is not a new technique. Originally it was described by Brieger [1] and Schonborn [2] and later modified by Winkler,[3] Beck,[4] Hoffman,[5] Bergara,[6-8] Tato,[9] Gibson and Walker,[10] and Macbeth.[11] It has had rather slight attention paid to it in this country, however. When Beck [4] first proposed this operation, objections were presented: first, that it might be difficult to obtain good approximation of the bony flap when it was returned to its original position; second, that osteomyelitic infection of the bone would be difficult to overcome. In other words, it was not received with great enthusiasm. Subsequently, the method of Lynch [12] with its modifications was widely adopted in the United States. In our experience [13] the Lynch operation has had drawbacks in that the surgically constructed nasofrontal passage was too often obstructed by scar tissue, and to maintain patency of the new passage various devices were needed. This led to modifications, such as were advocated by Walsh [14] and Brown,[15] to leave the nasofrontal duct membrane intact. Another difficulty encountered in the approach through the floor of the frontal sinus was that of reaching all the recesses of the cavity in order to remove the mucous membrane. In the obliterative technique of Riedel, the removal of the anterior wall without removing every vestige of mucous membrane would inevitably lead to mucoceles or pyoceles, and there was also a formidable deformity requiring a secondary plastic repair.

The anterior osteoplastic approach has several advantages:

1. There is the unexcelled opportunity to inspect the frontal sinus cavity, whereby with electrically operated burs the mucous membrane can be more completely removed.

2. A better view of the nasofrontal duct can be obtained in such cases where its preservation is desired, or it can be more easily blocked in cases where the complete obliteration of the cavity is desired.

3. By the use of electrically operated drills and saws the bone flap can be very carefully cut so that reapproximation is no problem at all.

4. There is no deformity.

Submitted for publication May 12, 1958.

Consulting Surgeon (Dr. Goodale) and Assistant in Laryngology (Dr. Montgomery), Massachusetts Eye and Ear Infirmary.

5. There is no interference with the pulley, so diplopia is avoided.

6. The medial orbital wall is not destroyed.

Possible disadvantages can be obviated as follows:

1. With antibiotics the problem of spread of infection to the bone with the danger of osteomyelitis is eliminated.

2. One must be careful in this technique not to injure the posterior wall of the sinus if it is decalcified as the result of mucocele or pyocele formation.

3. Careful mapping of the sinus is essential in order to make one's bone cut within the confines of the cavity.

II

The following case histories are presented with comments. The first four are by R. L. Goodale. Cases 5, 6, and 7 are by W. W. Montgomery.

CASE 1.—Woman, age 36, was operated upon at the Massachusetts Eye and Ear Infirmary on Feb. 3, 1955, for an exacerbation of a chronic frontal sinusitis. At that time a Lynch fronto-ethmosphenoidectomy was performed, and to maintain the patency of the nasofrontal duct a tantalum foil strip was inserted. This maintained the patency of the duct, but the patient continued to have reinfection of the frontal sinus with occasional inflammatory edema of the eyelid. Also there were several occasions when headache was a prominent symptom. It was finally decided, as the condition did not clear up with antibiotics or with autogenous vaccines sufficiently to guarantee freedom from further infection, that an obliterative operation would be desirable. On June 19, 1956, a right obliterative frontal sinus operation was performed by the anterior approach. The supraorbital incision was reopened down to but not through the periosteum. A vertical incision in the midline was then made, likewise avoiding the periosteum, and a triangular flap was reflected, allowing the periosteum to be still in contact with the underlying bone. A somewhat curved incision was then made through the periosteum along a line just within the upper limit of the sinus. The periosteum was not incised inferiorly along the supraorbital ridge. With an electrically driven circular saw, the anterior wall was resected along this line of incision. Then with mallet and chisel the outer and medial angles of the supraorbital ridge were severed. The bone flap was then turned down, thus giving direct exposure of the frontal sinus. The frontal sinus was found to contain thickened mucopurulent secretion. The mucous membrane was then stripped from the bone in every direction. Tantalum foil and wire were removed. The bony surfaces were then polished with an electric bur to remove all remnants of mucosa. After this, fat was taken from the abdominal wall and trimmed and fitted into the frontal sinus cavity in the manner of Bergara and Tato. The bone flap was then replaced. The periosteum was sutured with chromic absorbable surgical sutures, and the

Fig. 1 (Case 1).—Preoperative.

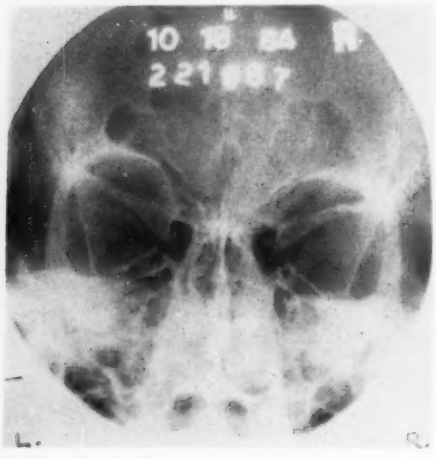


Fig. 2 (Case 1).—Postoperative. Osteoplastic bone resection and fat implant.

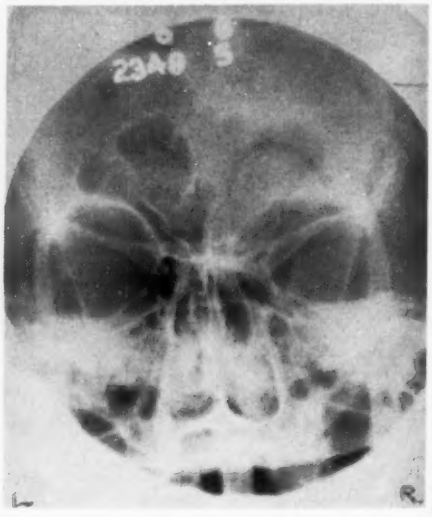


Fig. 3 (Case 1).—Postoperative result. Note line of previous Lynch incision.

skin incision was closed with 5-0 Dermalon sutures (skin and tension sutures processed from nylon). An adhesive tape was then applied as a splint, and pressure was applied by means of dry dressing and Ace bandage. Since this operation the patient has had no headache, no reinfection of the frontal sinus, and very few upper respiratory infections. What infection she has had has not affected the right frontal sinus (Figs. 1, 2, and 3).

CASE 2.—Woman, age 57. Five years prior to the present illness this patient had had an operation for right chronic frontal sinusitis, at which time a Riedel obliterative operation and implantation of an autogenous bone graft were performed with good results. This was the culmination of frontal sinus infection with multiple operations of a Lynch type previous to the obliteration. In November, 1956, the patient reentered the Massachusetts Eye and Ear Infirmary for an acute exacerbation of a left frontal sinus infection. At this time a trephination of the frontal sinus was done to evacuate the pus, but, as the infection continued in spite of penicillin and novobiocin (Albamycin), it was decided to use the anterior wall approach and obliterate the sinus with implantation of autogenous tissue. An incision was made from the midline just above the eyebrow in a horizontal direction to a point just beyond the outer angle of the frontal sinus and another incision at right angles to this in the midline, so that an L-shaped flap was made through the skin, down to but not through the periosteum. This flap was dissected away from the periosteum and reflected upward so that the periosteum was exposed. An inverted "V" cut was made with the knife from the medial limit of the frontal sinus upward just within the limits of the frontal sinus cavity and then downward and outward to a point near the outer angle of the sinus. With a circular saw held in such a fashion that a beveled cut through the bone would be made, the bone was incised through this periosteal incision. With a blow of a straight-edged chisel at the medial and lateral extremities of this cut, the supraorbital rim was sharply divided. It was very easy then with an elevator to lift up the flap, causing a slight fracture through the floor of the sinus, thus allowing the flap to turn downward and outward. This gave an extremely good view of the sinus cavity. The mucous membrane was removed, and the underlying bone of the cavity was polished with an electric bur. This removed all microscopic vestiges of mucous membrane. The nasofrontal duct was then examined. The mucous membrane was cut at this point and inverted downward into the nose, thereby obtaining a bare bony surface in the region of the frontal duct. An incision was then made in the abdominal wall to obtain some fat with attached aponeurosis. This was trimmed to fit the frontal sinus cavity, the aponeurosis being placed in the nasofrontal duct region. The bone flap was then replaced. The periosteum and the skin flap were laid down again in their original positions, and the wound was closed by interrupted Dermalon sutures. A pressure bandage was applied. This patient made an excellent and uneventful recovery. Her headaches and infections have completely disappeared. She has had no evidence of upper respiratory difficulty. Erythromycin was given preoperatively and postoperatively, as the organism which was recovered was a Staphylococcus sensitive to this drug (Figs. 4 and 5).

CASE 3.—Man, age 58. Patient was first seen on Jan. 9, 1957. He had had an operation several years ago—intranasal ethmoidectomy and enlargement of the nasofrontal duct. Of late the patient noted increasing swelling in the supraorbital area, especially within the orbit near the outer angle of the frontal sinus. An x-ray showed a pyocele in the frontal sinus with marked thickening of the bone medial to the pyocele. A right radical osteoplastic frontal sinus operation was performed on Jan. 11, 1957. A supraorbital incision was made just above the eyebrow from the midline to the outer limit of the sinus down to but not through the periosteum. The overlying soft tissues were then dissected carefully away from the periosteum. The supraorbital nerve branches were discovered

Figure 4

Fig. 4 (Case 2).—Before osteoplastic operation. The right obliterative frontal sinusectomy with bone graft repair. There are a few postoperative mucoceles. Left anterior osteoplastic frontal sinus and left intact. The sinus was outlined and measured previously by means of x-ray. Then the outline of the sinus was demarcated by an incision through the periosteum in a curve starting at the inner end of the supraorbital ridge extending upward, then laterally, then downward to the outer limit of the frontal sinus. With an electrically driven circular saw a beveled cut was made through the front wall of the frontal sinus. The supraorbital rim at the ends of this cut was then divided by mallet and chisel. The sinus was then observed to have two compartments. Laterally

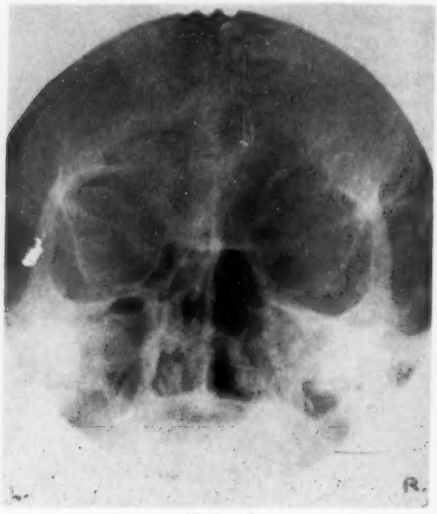


Figure 5

operation with fat implant. The ethmoid and antrum were not involved on the left.

Fig. 5 (Case 2).—After osteoplastic operation.

Fig. 6 (Case 3).—Preoperative film shows pyocele of the right frontal sinus.

Fig. 7 (Case 3).—Postoperative film shows bone resection and considerable sclerosis except where the pyocele had eroded. As the nasofrontal duct was normal, the sinus was not obliterated.

Figure 6

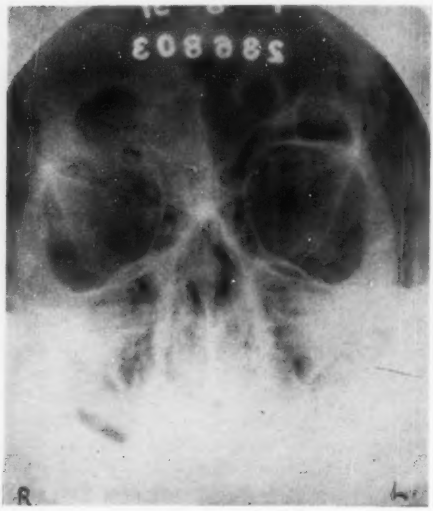


Figure 7

Fig. 8 (Case 3).—Postoperative result. No deformity. Very slight evidence of incision just above the right eyebrow.

there was a large pyocele with erosion of the posterior wall so that the dura was adherent to the pyocele itself. The medial portion of the cavity with normal mucous membrane communicated readily through a normal nasofrontal duct with the nose. Between these two areas was a bony lamina and an adhesion from this lamina to the anterior wall of the sinus. This was removed. The cavity was then washed clean and dusted with chloramphenicol (Chloromycetin) powder. The wound was closed in the same manner as in the previous case. Prior to the operation the patient had had some diplopia because of the swelling in the supraorbital area. After the operation this completely disappeared. All headaches have disappeared. Patient was given erythromycin postoperatively, as the culture showed Staphylococcus aureus sensitive to this drug (Figs. 6, 7, and 8).

Case 4.—Woman, age 39, first seen on Sept. 27, 1957, with the following history. About 12 years previously she had had a right Lynch frontal operation elsewhere and following this had considerable trouble because of reinfection of the sinus. Actually as time went by the nasofrontal duct closed, and when I first saw her she showed a bulging of the interfrontal septum across the midline and into the left frontal sinus area. Also there was a rather hard firm swelling just beneath the eyebrow, pushing down into the orbit. The x-ray was consistent with a pyocele of the right frontal sinus. At operation on Oct. 18, 1957, it appeared that instead of a pyocele, it was actually an empyema of the sinus which had by pressure bulged the interfrontal septum and also the floor of the sinus. The nasofrontal duct was completely occluded, and, as there was no bony floor remaining on this side, it was decided to remove the interfrontal septum entirely. As it was impossible to remove all the mucous membrane from the right sinus, frontal obliteration was contraindicated. From here on, the right sinus would be expected to drain into the left sinus and out through the left nasofrontal duct. This procedure is contrary to the teaching of many schools. However, it was successfully accomplished, and the patient has had no subsequent infection of the left frontal sinus from the transfer of the septic material from the right side into the left. Probably the use of antibiotics may remove the objections to this type of operation. Since then the patient has had an uneventful recovery and at the present time she is symptom-free for the first time in 12 years (Fig. 9).

Case 5.—A 31-year-old white man had onset of right frontal headaches in May, 1957, during an upper respiratory infection. These headaches were much worse during the day. Two weeks later there developed redness and swelling in the right supraorbital region over the frontal sinus. The area was incised and drained pus for two days. Antibiotics were used at this time. The right frontal headache continued until the time of admission in August, 1957. There was no other past history of sinus disease. He had no nasal or postnasal complaints. At the time of his admission

Fig. 9 (Case 4).—X-ray two months after operation, showing the bone resection of the right frontal sinus. Note the removal of the interfrontal septum and the sclerosis in the right ethmoid region. The ethmoid was well exenterated by another surgeon previously.

physical findings were limited to a small scar in the right supraorbital region and tenderness over the right frontal sinus. Sinus x-rays showed a mucocele in the right frontal sinus, an absence of the interfrontal septum, and a left antrum one-half full. On Aug. 14, 1957, an osteoplastic flap was cut by way of a right supraorbital incision. A large pyocele, containing thick green purulent material, was found in the right frontal sinus. The interfrontal septum was absent. Since the left frontal sinus was extremely small, both frontal sinuses were obliterated with fat from the abdominal wall. Penicillin and streptomycin were used for one week postoperatively. Repeated x-rays since the time of operation have shown obliterated frontals. The left antrum cleared spontaneously.

CASE 6.—A 57-year-old white woman underwent a Lynch frontal sinus operation in May, 1955, for a large osteoma in the right frontal sinus. Her preoperative symptoms had been nasal discharge and right frontal headaches. Exactly two years later she returned, complaining of pain in the right forehead of six months' duration. Physical findings were nil. Sinus x-rays showed a mucocele in the right frontal sinus. In June, 1957, an anterior osteoplastic approach was used to obliterate the right frontal sinus with fat from the abdominal wall. Since a previous Lynch frontal had been performed, the inferior aspect of the bone flap (orbital rim) was left attached to the subcutaneous tissue to insure a blood supply to the periosteum. Erythromycin and chloramphenicol were found to be the antibiotics of choice for her postoperative protection. These were continued until the time of discharge from the hospital on the seventh postoperative day. Repeated x-rays since the time of this operation have shown an obliterated right frontal sinus. The patient has thus far remained symptom-free.

CASE 7.—A 51-year-old white man was first admitted to the Massachusetts Eye and Ear Infirmary in February, 1957, complaining of a severe throbbing right frontal headache of one week's duration. At the age of 25 years a submucous resection of the nasal septum and intranasal polypectomy were carried out for relief of poor nasal respiration. He did well after this operation, until 1945, when intermittent hoarseness became a problem.

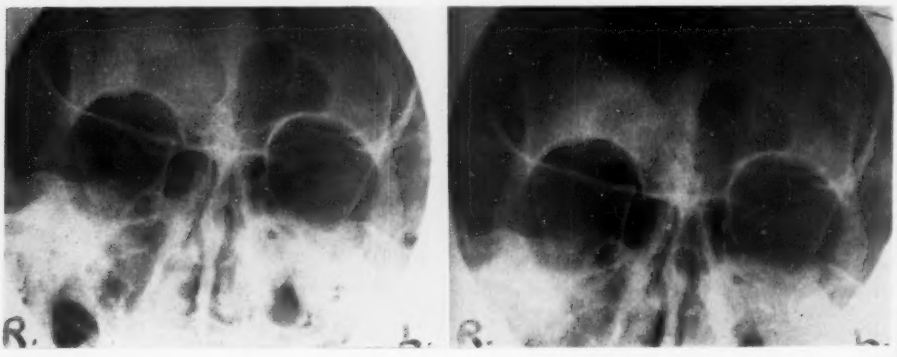
X-rays of the sinuses were taken at this time while a purulent discharge in both middle meatus was being investigated. There x-rays showed a right pansinusitis. Local measures to the nose and pharynx were sufficient to relieve the hoarseness and purulent rhinorrhea. The examination in February, 1957, revealed a tenderness and swelling in the region of the floor of the right frontal sinus. Sinus x-rays were consistent with a pyocele in the right frontal sinus. An osteoplastic flap approach for obliteration of the right frontal sinus with fat from the abdominal wall was carried out. Postoperatively erythromycin and chloramphenicol were used to control a hemolytic Staphylococcus aureus, cultured from the pyocele in the right frontal sinus. Postoperative x-rays have shown an obliterated right frontal sinus. The patient has remained symptom-free. There is no deformity and a nearly invisible scar (Fig. 10).

III

From the experience gained from these cases, we recommend the following procedures in the surgical technique of the anterior osteoplastic frontal sinus operation.

1. Preparation of the patient. Preoperative bacteriological cultures from the nose should be taken and the organism tested for antibiotic sensitivity. This should be done several days in advance of surgery so that

Fig. 10 (Case 7).—This was a frontal sinusitis without involvement of the other sinuses. The postoperative film shows the bone resection. Fat was implanted into the cavity.



the appropriate antibiotic drug may be given immediately before and after the operation.

2. A complete blood study, including estimation of platelets, prothrombin, and bleeding time. Patient should be typed for transfusion so that in case blood should be needed during the operation, it will be readily available.

3. If transplant of fat tissue from the abdomen is intended, an area in the right or left lower quadrant should be prepared as for a laparotomy.

4. It is important not to shave the eyebrow. No special preparation of the face is necessary.

5. X-rays must be taken and the measurements of the frontal sinuses accurately made by calipers or a centimeter ruler so that the extent of the sinus can be determined before operation. It is advisable to cut out a pattern from one of the x-ray films which will give a trace outline of the frontal sinuses. This can be sterilized in aqueous benzalkonium (Zephiran) and then directly applied to the frontal area during the operation.

6. Patient lies on the table in a supine position with the head slightly raised and inclined forward so that the plane of the forehead is horizontal.

7. Patient is draped in the usual manner.

8. The eyelids are stitched together with a 4-0 Dermalon suture to protect the eyes during the operation.

9. The anesthetist is given full jurisdiction over the type of anesthesia. Generally we prefer intravenous thiopental (Pentothal) with endotracheal tube and hypopharyngeal packing. During the operation intravenous dextrose is given, and, if transfusion is anticipated, blood is ordered and given during the operation.

10. We find it advantageous for the surgeon to stand at the head of the table except when cutting the bone flap. In this way he has an unobstructed view of the frontal sinus cavity after the bone flap has been reflected forward and downward. The assistant may stand on either side, and the anesthetist on the opposite side.

11. The skin is sterilized with aqueous solution of benzalkonium.

12. As bleeding may be fairly profuse in this area, it is helpful to infiltrate the soft tissues of the forehead with 2% procaine and epinephrine.

13. Instruments. The usual frontal sinus instruments commonly used in a Lynch or Killian operation are requisite. There should be a sufficient number of small curved hemostats, as the bleeding may be profuse from the skin edges. Mallet and straight-edged chisel should also be available. A periosteal elevator or an elevator similar to those used in a submucous resection should be provided. The extra equipment includes the electrically operated dental drill, which should be provided with bone-cutting burs and with a small circular saw. If the circular saw is not used with this equipment, the Stryker * saw should be provided. In cutting the bone flap, the smaller of the two Stryker saw blades is preferable (Fig. 11).

14. Incision. The incision is made horizontally just above the eyebrow from the outer limit of the sinus medialward to the inner end of the eyebrow. If it is an extremely large sinus, a vertical incision in the midline to provide a V-flap may be necessary. In this case incision No. 1 must be carried to the midline. It is carried down to but *not* through the periosteum. This is important, as the blood supply must be preserved through an intact periosteum. All bleeding must be controlled at this stage of the operation.

15. Elevation of the soft tissue. With scissor dissection the skin and muscle layer is separated from the periosteum and retracted upward. The exposure must be wide enough to extend at least ½ in. beyond the limits of the sinus.

16. Mapping the periosteal incision. This is carefully measured on the x-ray film from

* "Stryker," high-speed oscillating bone saw manufactured by the Orthopedic Frame Company, Kalamazoo, Mich.

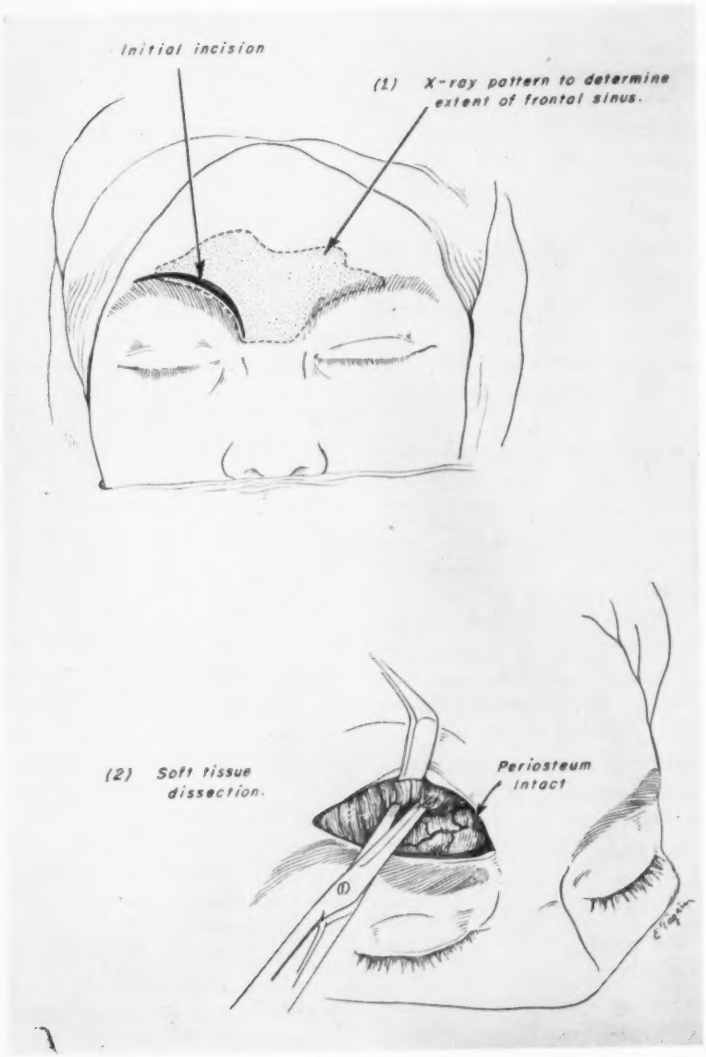


Figure 11

the midline and supraorbital rim. Sterile calipers or metal ruler can be used, or a pattern cut out from the x-ray film and sterilized in aqueous benzalkonium can be placed directly over the sinus. This pattern should be trimmed so that it is actually slightly smaller than the sinus. It is then placed over the corresponding area of the patient's forehead both as a guide in estimating the extent of the soft tissue elevation and then in outlining the periosteal incision after the soft tissues have been elevated (Fig. 12).

17. The periosteal incision. This incision is made by a scalpel along the upper margin of the pattern. Again we emphasize the periosteum is *not* to be incised along the lower supraorbital margin (Fig. 13).

18. Cutting the bone flap. Originally we have used a small circular bone-cutting saw

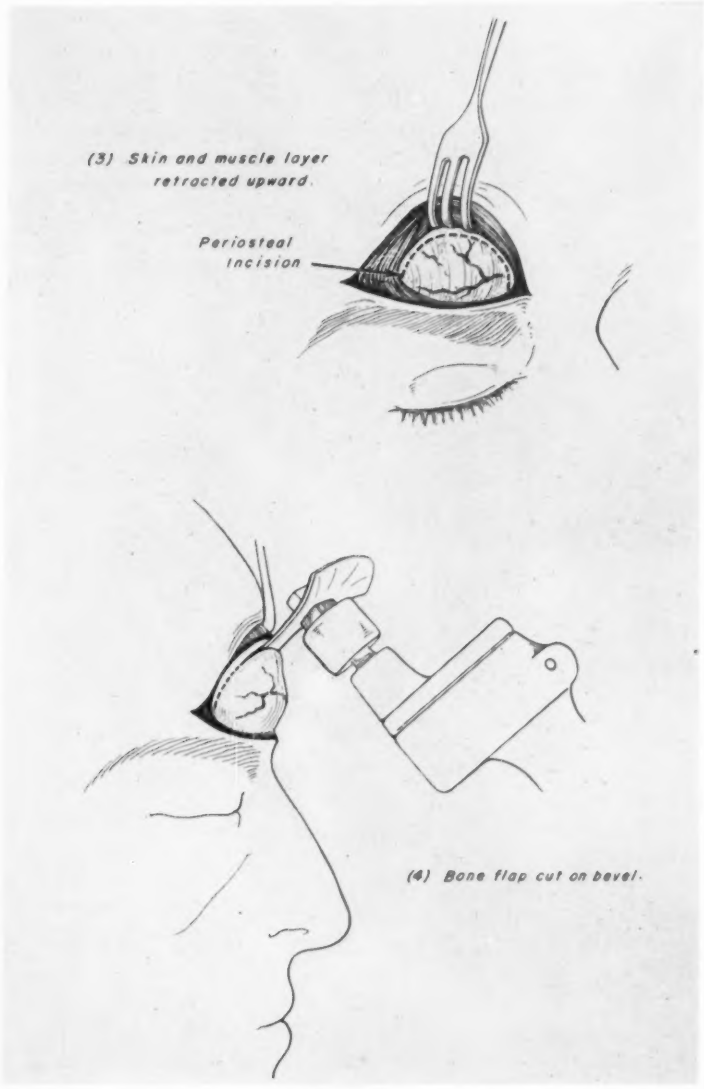


Figure 12

attached to the electrically driven motor used in dental work. The saw blade is tilted slightly downward so that a beveled cut is made through the bone into the sinus. This cut follows the line of periosteal incision. At either end of this bow-like cut the heavier bone of the supraorbital ridge is encountered. The easiest way to cut through this is to give a sharp blow with a straight-edged chisel. Immediately the bone flap appears to loosen and can be pried up by a periosteal elevator, or the thin floor of the sinus gives way easily by linear fracture. This poses no problem during the operation or postoperatively. This bone flap, then being turned downward and outward, may be retracted by means of hooks. An improvement over the circular saw is

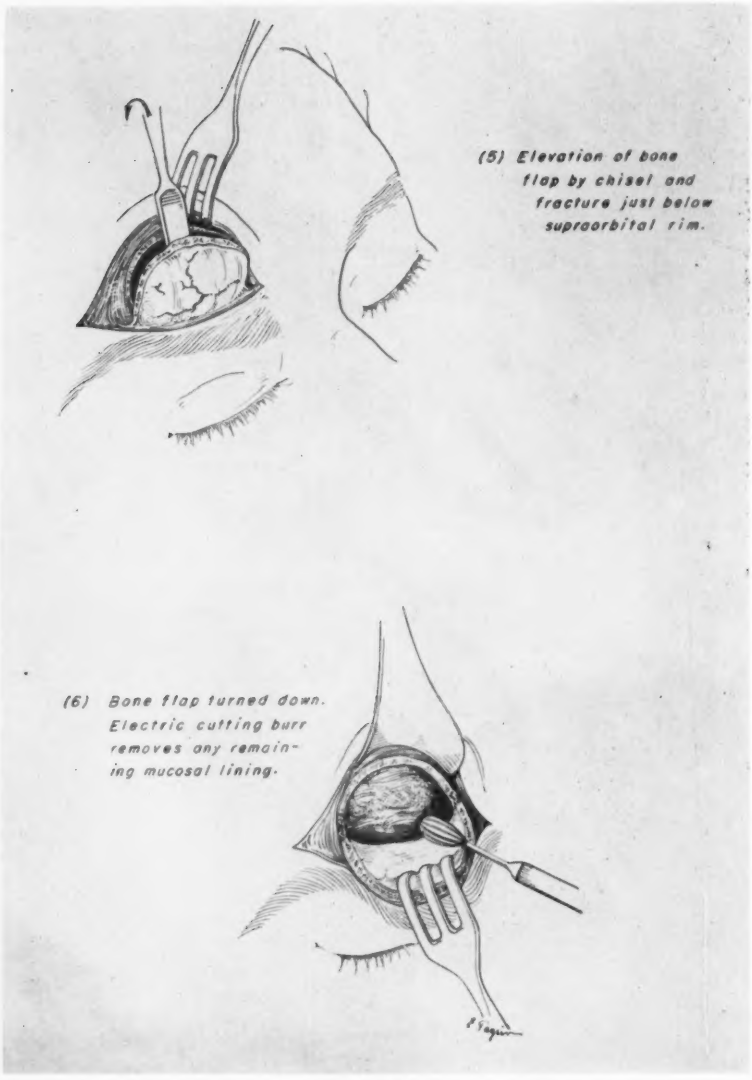

(5) Elevation of bone flap by chisel and fracture just below supraorbital rim.
(6) Bone flap turned down. Electric cutting burr removes any remaining mucosal lining.

Figure 13

the Stryker saw, which is an oscillating saw and less likely therefore to damage soft tissues such as the dura in case this later is exposed by disease. At the present time this is the instrument which we prefer.

19. Inspection of the sinus. With the bone flap turned down, the entire cavity is exposed to direct and immediate inspection. The extent of the pathology can be noted and the next steps decided upon. If the original plan is still valid, well and good. If a new or different factor is discovered, a change in procedure is easy and nothing so far done would be a hindrance to such a change. At this point we would be guided by the pathological picture. For instance,

A. Where merely a local lesion is to be removed, such as a mucocele or pyocele, or where the nasofrontal duct is normal or capable of returning to normal after the

diseased tissue is removed, we can dissect away all the pathology by means of a submucous resection elevator or curette. We base-level the partial bony septa but leave the mucous membrane in the immediate vicinity of the nasofrontal duct intact. If the floor of the sinus has been bulged downward by pressure from a mucocele, this bulging may be reduced by simply pushing the bone upward with one's thumb as suggested by Goodyear.[17] The bone being quite yielding, it is readily put back to its proper location.

B. Where the normal drainage is no longer possible, all mucous membrane must be removed and the sinus obliterated. This means destruction of the nasofrontal duct. In this case we find that mere curettage of the mucosa of the sinus is not sufficient. All mucous membrane must be removed first by dissection, and then the surface of

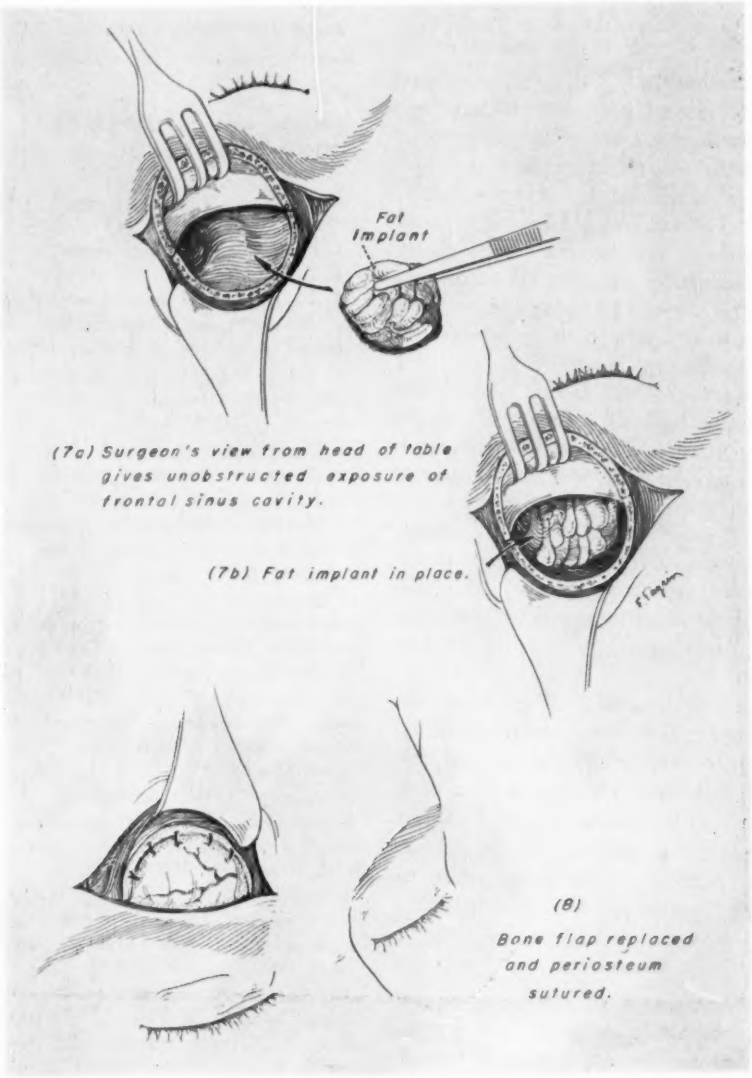

Fat
Implant
(7a) Surgeon's view from head of table gives unobstructed exposure of frontal sinus cavity.
(7b) Fat implant in place.
(8)
Bone flap replaced and periosteum sutured.

Figure 14

the bone must be ground away by the electric bur. If the superficial layer of the bone is thus removed, it also takes away the small islands of mucous membrane which lie imbedded in microscopic amounts in the bony surface. The mucous membrane in the nasofrontal duct area is curetted out and the remaining edges of mucous membrane pushed down into the nose. The bony margins are roughened by the curette; this should stimulate granulation formation and subsequent occlusion by scar tissue (Fig. 14).

20. Fat implant. The assistant changes gown and gloves and with a separately sterilized dissecting set obtains a block of fat and subjacent rectus muscle aponeurosis through a horizontal left lower quadrant incision. The fat thus obtained is trimmed so that it will just fill the frontal cavity. The aponeurosis is placed in the nasofrontal duct of the sinus. The abdominal wound is then closed in layers in the usual manner, and a dry dressing is applied.

21. Closure of the frontal sinus. The bone flap is replaced so that the beveled bone edges are in good approximation. It is surprising how easily this is accomplished by simply maneuvering the flap back into its original position. Periosteum is sutured by 4-0 chromic absorbable surgical sutures. Soft tissues are then replaced. The skin incision is closed with interrupted 5-0 nylon sutures. An external dry pressure dressing is applied.

22. Postoperative care. The proper antibiotic having been determined previously, this is administered as long as there is evidence of infection. The pressure dressing is removed on the second day. Subsequent light dressings are applied over the incision until the stitches are removed, which is usually on the fifth postoperative day.

Summary

The advantages of an anterior approach to the frontal sinus are given, and a technique based on the experience of earlier surgeons and on our own experience is presented, together with case histories of seven patients. In five cases fat from the abdominal wall was used to obliterate the frontal sinus by the method of Bergara and Tato. In one case, where the nasofrontal duct was patent and the sole pathology was a cyst, the cavity was not obliterated after the removal of the cyst. In one case where the interfrontal septum was gone, the infected mucosa was removed, the interfrontal septum further removed, and the duct on the healthy side relied upon to take over the function of ventilation and drainage.

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Vocal Rehabilitation of Paralytic Dysphonia

IV. Paralytic Dysphonia Due to Unilateral Recurrent Nerve Paralysis

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Present Interpretation of Laryngoplegic Findings

Previous papers were devoted to the clarification of certain pathologic concepts dealing with laryngeal paralysis. Until further information will resolve some remaining discrepancies in the analysis of laryngeal neurology, we may follow the detailed presentation by Pressman and Kelemen.[53] These authors join a large group of investigators in assuming that *midline position* of the paralyzed vocal cord usually indicates complete paralysis of the inferior laryngeal nerve. Abducted position in the *intermediate line*, however, is generally interpreted as a sign of combined and complete paralysis of both the inferior and the superior laryngeal nerves. In order to identify the accepted terms for the various vocal cord positions, Figure 1 summarizes the definitions used in this discussion.

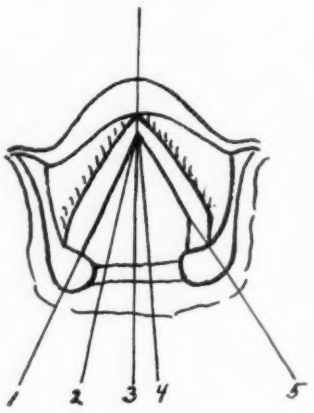

Fig. 1.—The five lines of laryngoscopic orientation: 1=line of abduction; 2= intermediate line; 3=median line; 4=paramedian line, 5=extreme abduction during deep inspiration with pentagonal glottis.

It was a peculiar coincidence that three independent authors published three extensive reviews of the same problem and came to very similar conclusions: Berendes[9] in May, 1956; Tschiassny[66] in February, 1957, and Arnold[5] in May, 1957. Being fully aware of the continuing discussion on the significance of the position of paralyzed vocal cords and presenting all divergent views, these three authors favor the modern interpretation as outlined before. As will be seen, this concept helps the understanding of the vocal signs of laryngeal paralysis because the degree and type of paralytic dysphonia depend on the position of the paralyzed cord.

Laryngoscopic Findings and Vocal Disorders

Many publications on vocal disorders as a result of laryngeal paralysis stressed the fact that the degree of the individual vocal disability may be very variable. For this reason the earlier authors limited their statements to general comments. However, it soon became a matter of universal agreement that paralytic dysphonia depends on several specific factors: (1) the type of onset of the paralysis; (2) the position of the immobilized cord; (3) the permanent structural changes within this cord, such as atrophy with a bowing appearance; (4) the shape of the glottis; (5) level differences between the cords; (6) the position of the

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From the Diagnostic Services (G. E. Arnold, M.D., Clinical Director) of the National Hospital for Speech Disorders in New York (Lynwood Heaver, M.D., Director).

arytenoid; (7) the type and degree of compensation achieved by the unaffected laryngeal structures, and (8) the patient's emotional reactions to his disability and his individual skill in overcoming it.

During the two World Wars several phoniatric specialists accumulated a large number of observations on the relationship between the organic laryngeal findings and the functional disturbance of the voice. Among these authors were Seemann,[56] Stern,[58] Neumayer,[47] Flatau,[16] and Döhne.[13] In his monograph on traumatic voice disorders Arnold [2] gave a detailed description of 205 cases of laryngeal paralysis. Of these, 100 cases were of traumatic origin; 55 followed thyroidectomy, whereas the remaining 50 cases included various other etiologies. Owing partly to the numerous gunshot injuries, the left side was affected 110 times (53.7%), while the right side was paralyzed in 84 cases (40.9%). The remaining 11 bilateral conditions (5.4%) included 3 cases of bilateral median position. Bellussi [7] selected this presentation for his outline of the phonetic problems in laryngeal paralysis.

On the basis of these analytic discussions of vocal symptomatology in cases of laryngeal paralysis, it is now possible to make more specific statements on the various types of paralytic dysphonia. As will be seen, the course of paralysis is determined by the type of onset, namely, the *acute onset* and the slowly *progressive development*. This distinction was first made by Seemann [56] in 1919. In addition to this differentiation of acute and chronic development of the paralytic lesion, it is customary to distinguish between the visible signs of laryngoplegia and the audible findings of the vocal disorder. We thus arrive at the confrontation of the laryngologic stages of paralysis with the phonetic stages of dysphonia. Their sequence also depends on the type of onset.

Acute Onset of Laryngeal Paralysis

Many observations of a sudden appearance of laryngeal paralysis permit some general conclusions with regard to its effect on the voice. Most of the cases were observed after thyroidectomy. Further causes include other types of cervical surgery or traumata, as well as toxic, infectious, or allergic manifestations. This variety of etiologic factors is important for the interpretation of the paralytic process, particularly for the explanation of the vocal cord position.

I. Stage of Complete Aphonia.—All authors agree that the sudden onset of a paralytic lesion causes a very severe degree of vocal disorder. As a rule the voice is totally lost or aphonic. This is due to the fact that the suddenly paralyzed cord usually stands in *intermediate* position. Many authors agree with this concept: Döhne,[13] Oltersdorf,[50] Hartenau and Schwetz [23] (in cats), Gleitsmann,[20] New and Childrey,[49] Seemann,[56] Berendes.[8,9] As seems to be typical for every detail of laryngeal innervation, other authors came to different conclusions because they found the recently paralyzed cord in *paramedian* position: Lemere [36] (in dogs), Arnold [3] (in dogs), Kuttner [5] (in dogs), New and Childrey,[49] or Gisel and Pichler.[19]

As a result of the intermediate position of the paralyzed cord the glottis can no longer be closed. For this reason the expiratory air stream does not cause intermittent vibrations of the cords which do not close. Rather, the expelled air produces only a rough and weak noise. This explains the completely aphonic and poorly audible voice of the acutely paralyzed patient. A feeble whispering is heard whenever he tries to talk with greater effort. As soon as the patient manages a partial closure of the glottis with the help of the healthy cord or by utilizing the constrictive effect of the extralaryngeal muscles, the expiratory air stream meets with a partial narrowing. Instead of periodic vocal cord vibrations this narrowing then produces irregular noises by friction and by creating air eddies. These give the impression of a weak, rough, and very hoarse voice.

Stroboscopy illustrates the irregularity or absence of vocal cord vibration in this stage.

A typical disorder of *respiration* is explained by the pathologic aerodynamic principles. Since a large portion of the expired air stream is not transformed into sounding voice and escapes as unused air, the so-called "wild air," the patient is wasting his phonatory air. His voice efforts sound breathy and he claims to be short of breath. In reality he is not actually dyspneic, but he appears so because he can say only a few words with each expiratory phase. This reduces his phonation time, shortens his sentences, and causes frequent inspirations or *tachypnea*. The details of pathologic respiration in paralytic dysphonia, such as frequency, duration, expansion, velocity, synchronism, and respiratory type, were analyzed by Panconcelli-Calzia.[51]

II. Stage of Severe Dysphonia.—This stage develops after a variable length of time. Gradually the forces of compensation improve the intralaryngeal processes of glottal closure. First, we have to consider the extrinsic laryngeal muscles which are not affected by the paralysis. Tarneaud[60,61] described their influence on normal phonation and on the mechanism of compensation. By molding the elastic laryngeal cartilages they contribute to a better glottal closure during phonation. This is one reason why old people are much less prone to compensate their paralytic dysphonia, for their calcified and rigid larynx can no longer be compressed by muscular forces. A certain tension and fixation of the paralyzed cord is also exerted by the single interarytenoid muscle, which receives a double innervation from both sides. As a result of a better glottal closure the voice becomes louder and regains some vocal quality. Yet, it remains very hoarse, weak, breathy, and polypneic, with a very short phonation time. Correspondingly, the vocal range is limited to a few noisy tones.

III. Stage of Flutter Voice.—The term "Flatterton" was originated by Seemann,[56] who observed passive and flapping movements of the flaccid cord while a weak and irregularly rasping tone was heard. Although the glottis appears narrower in this stage, the two cords are unable to perform any regular and symmetrical movements. There are several reasons for this increasing constriction of the glottis. Many authors had observed a tendency of the paralyzed cord to shift from an initial intermediate position to a subsequent paramedian position: New and Childrey[49] found this change in the majority of cases within a few months; Hartenau and Schwetz[23] saw it after a few hours (in cats); O. H. Meurman[9] attributes this transition to a contracture of the active cricothyroid muscle; Berendes[9] joins Hofer and Jeschek[25] in explaining such changes as a partial recovery of the superior laryngeal nerve, which then causes the external tensor to adduct the paralyzed cord to the paramedian line.

Vocally, the third stage of the typical flutter voice of laryngeal paralysis is characterized by the following phenomena. Owing to the different tension of the two cords, there is a tendency to double tones or *diplophony*. The pitch usually appears elevated because the partially abducted and flaccid cord cannot provide the full closure of the glottis which is the prerequisite for the full vibrations of the chest register. The speaking tone therefore lies in the range of the *middle register*. Sometimes the pitch may be very low, even in a subtonal range at the lower border of the physiologic vocal range. In such cases men use vocal frequencies between 50 and 100 cps, while women speak in the range of 100-200 cps, which is of course much too low. Since all higher tones may be lost, the vocal range is very narrow. This also accounts for the marked vocal monotony. Registers cannot be differentiated for the same reason. In other cases the intact cricothyroid muscle is responsible for the appearance of the *falsetto voice*. By trying to improve his voice with increased effort,

the patient overcontracts the external tensors, and thus raises his speaking range to the falsetto register.

This *paralytic falsetto voice* is further due to the oval shape of an incompletely closed glottis. Usually the paralyzed cord is then found in paramedian or slightly more abducted position and in a flaccid, atrophic, and bowing condition. As is well known, this oval shape of the glottis is the physical basis for the physiologic falsetto register. Falsetto tones must be sung with an oval glottis; conversely, an oval glottis tends to produce falsetto tones. As a direct result of the *increased opening quotient* of a bowing glottis the phonation time is very short. This causes the loss of volume and explains the extreme vocal fatigue. It is no wonder that all higher qualities of the voice are totally absent: correct intonation, modulation, singing, or calling aloud.

IV. Stage of Slight Dysphonia.—Several months later the forces of intralaryngeal compensation bring about a further narrowing of the phonating glottis with a subsequent reduction of the phonatory air consumption. At this stage the air volume can be adjusted to the informative content of the phrase or sentence. While the speaking pitch becomes consolidated, the vocal range and the volume continue to increase. In accordance with the improved glottal closure the phonation time appears lengthened; the waste of air is diminished; diplophony and hoarseness can be compensated to a certain degree. The extent of this vocal compensation depends on the individual conditions of underlying pathology, the possibility of its partial reversal, the position, residual motility, and atrophy of the paralyzed cord, and finally on the age, general health, motor ability, and musical talent of the patient.

V. Stage of Fully Compensated Voice.—A complete recovery from the vocal disorder may be expected after all visible signs of laryngeal paralysis have subsided, as Gleitsmann [20] had described in 1901. In cases of permanent paralysis, however, spontaneous compensation of all vocal defects is very rare. Usually the untreated patients retain variable degrees of hoarseness and vocal weakness, and remain in the stage of residual dysphonia.

Chronic Progress of Laryngeal Paralysis

A completely different course of paralytic dysphonia is evident in cases of slowly developing paralytic lesions. Since the changes in the affected cord, namely, of its motility, shape, position, and tension, appear gradually, there is sufficient time for the spontaneous evolution of the intralaryngeal compensatory forces. For this reason the vocal disability manifests itself very slowly and may remain latent until a coincidental laryngologic examination. According to the rule of Rosenbach and Semon,[5] one is accustomed to distinguishing several consecutive stages of laryngeal paralysis. As explained in the preceding publication, these *five laryngoscopic stages* of visible paralysis are now interpreted in the light of recent neurolaryngologic findings. When analyzing the course of the audible findings of progressive paralytic disability, we are again confronted by the *five phonetic stages* of audible dysphonia as explained above. In slowly progressive lesions they show the reversed sequence of acutely beginning lesions.

I. Laryngoscopic Stage of Abductor Paralysis.—Although many authors confess never to have seen the signs of incipient and isolated abductor paralysis, these are nonetheless well established. We remember them distinctly from the observation of certain patients who later developed a typical laryngeal paralysis. According to the preceding papers, the function of the abducting posterior (or dorsal) cricoarytenoid muscle consists in the full abduction of the cord from the intermediate line to the line of lateral position. After relaxation of the posticus muscle the cord returns passively to the intermediate line. From here it is actively pulled to the paramedian line by the contracting adductors. Complete closure of the glottis at the median

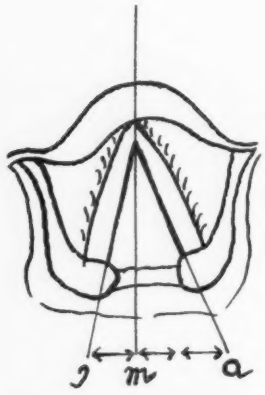

Fig. 2.—Pure abductor paralysis. The right cord relaxes passively to the intermediate line (*I*) during inspiration, but cannot be actively abducted to the position of full abduction (*A*). In partial abductor paresis the affected cord moves sluggishly lateral from the intermediate line. The left cord moves normally to the midline (*M*).

line is finally achieved by the expiratory and therefore phonatory function of the external cricothyroid muscle. After phonation this sequence is reversed and the relaxation of the adductors allows the cord to return passively over the paramedian line to the intermediate line (Stupka[59]). An incipient *paresis* of the inspiratory posterior cricoarytenoid will then cause a slow, sluggish, and incomplete abduction of the cord laterally beyond the intermediate line. Complete *paralysis* of the posticus muscle causes arrest of the abducted cord at the intermediate line, as Figure 2 shows. However, its adduction to the median position of phonation remains perfectly normal: (Klemperer,[34] Jurasz,[32] Weleminsky.[68])

I. Phonetic Stage of Fully Compensated Voice.—Since the normal adductors maintain the normal tension, adduction, and fixation of the affected cord during phonation, the voice usually remains normal in this stage. Even the singing voice of professional artists need not be altered, as several authors have confirmed: (Gleitsmann,[20] Jurasz,[32] Dorendorf,[14] Spiess,[57] Arnold.[2]) Complete paralysis of the respiratory abductor with limitation of abduction to the intermediate line usually does not disturb the speaking voice. If it does interfere with a singer's performance, this dysodia may be explained by the loss of posterior fixation of the arytenoid cartilage. Jurasz[32] believed this bracing action to be essential for perfect tension of the cords. In general, such minimal dysphonias or dysodias must be especially sought for with refined phoniatric methods. Garde's[18] differentiation of hypoexcitable and hypotonic cords by means of chronaxic and steroboscopic measurements appears valuable for these cases. According to his formula an elevated chronaxie plus *reduced* stroboscopic vibration indicates a hypoexcitable cord, whereas elevated chronaxie plus *increased* visual vibration is typical for a hypotonic cord. From the clinical viewpoint the findings of incipient abductor deficiency are important signs of a possibly progressive nervous lesion and demand careful examination and prolonged observation. This is the more important as respiratory disorders do not exist in this stage.

II. Laryngoscopic Stage of Median Position.—With the passage of time and the progress of the paralyzing lesion the cord is eventually seen in a fixed midline position. From now on it cannot be abducted at all (Fig. 3). As long as the rule of Rosenbach and Semon was considered

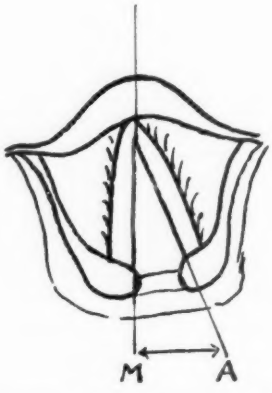

Fig. 3.—Inferior laryngeal nerve paralysis with median position of right cord due to its normal tension by the action of the superior laryngeal nerve. The left cord moves normally to the midline (*M*).

valid, this stage was interpreted as a reflex contracture of the adductors, including the external cricothyroid muscle. Since the theory of these observations was recently analyzed by Tschiassny,[66] we need not discuss it any more. Berendes[9] presented all pertinent views in his monograph on laryngeal motility and found sufficient explanations for the exceptional cases. He tends to favor the modern concept that the stage of median or paramedian position represents the correlate of *complete paralysis* of all recurrent nerve fibers. This view is also shared by Oltersdorf.[50] In any case, median position means loss of all motility, although the tonic innervation, possibly over the trophic sympathetic fibers via the arterial supply, is still intact. Hence, there will be no major loss of tension, which in any case is maintained by the unaffected external tensor. Since, then, the vocal cord remains permanently in the position of phonation and does not show any visible or gross signs of decreased tension, the voice also remains intact. Many patients in this condition are unaware of their lesion, until a chance laryngoscopy reveals their paralysis. It is quite typical that cases of syringomyelia or syringobulbia, cervical adenomata or mediastinal tumors may produce general symptoms, such as rotatory nystagmus, skin anesthesia, dyspnea, etc., without any phonic signs. Even the singing voice need not be greatly disturbed.

II. Phonetic Stage of Slight Dysphonia.

This stage is revealed by careful phoniatric analysis. In general, one may expect some audible signs of decreased vocal cord tension. These are manifested by a limited vocal range, loss of volume, shortened phonation time, disturbed modulation, or a loss of the higher vocal functions, such as artistic singing, calling aloud, and prolonged public speaking. When a disorder of singing is present, it can be explained by the level differences between the cords. As Spiess[57] had recognized in 1904, the paralyzed cord may be lower and show a vertical bowing because the arytenoid cartilage has lost its posterior muscular support and falls forward as a result of the cord's weight. This also makes the cord appear shorter. Because the vocal process of a partly flaccid cord is obscured by the prolapsed arytenoid, one cannot visualize the cartilaginous glottis and may overlook a posterior deficiency of adduction. According to Amersbach,[1] this may cause marked dysphonia. A visual demonstration of the pathologic vibratory mechanism is obtained by stroboscopy, as Tarneaud[60] had explained. The affected cord then shows reduced frequency and amplitude of vibration.

When a *vocal disorder* is associated with median position, it must be due to inefficient compensation. Some patients may speak in the subtonal range, while others cannot avoid the falsetto voice. Such voices are hoarse, diplophonic, fluttering, sometimes even aphonic. Due to emotional tension a hyperkinetic element may appear, forcing the healthy cord or the supraglottic sphincter mechanism into overcontracture, and adding a strained, tense, and choked quality to the hoarseness. Such secondary hyperkinetic disorders of function are associated with psychologic peculiarities: poor motokinesthetic control, lack of musical ability with inefficient acoustic control of phonation, nervous imbalance, psychoneurotic disorders, and the like. It is interesting to note that a well-compensated stage of median position may suddenly be overthrown by an attack of laryngitis. A previously good voice can then revert into the stage of severe dysphonia, simulating a sudden onset of paralysis although no organic change has taken place in the vocal cord. As is typical for all habitual or psychogenic dysphonias, the reflex types of phonation will then sound much better than the voluntary efforts: during laryngoscopy the voice may appear normal, whereas the patient's speaking voice sounds hoarse or even aphonic.

Respiratory disorders are not frequent in this stage of median position. During

rest the half-open glottis allows for a sufficient air exchange. With physical exercise a certain amount of dyspnea may develop. As a rule, the patients are well accustomed to this restriction and do not complain of it. Violent exercise may be impossible, but this is rarely deplored because the other symptoms of the underlying disease, such as neurogenic, cardiac, thyroid, or pulmonary pathology, preclude it anyway.

III. Laryngoscopic Stage of Paramedian Position.—As extensively discussed before, this situation is now generally correlated with the condition of *complete paralysis* of all muscles innervated by the recurrent nerve. This concept agrees with Lemere's [36] experimental findings in complete section of the recurrent nerve. Berendes [9] presents further evidence for the pathologic explanation of paramedian position as the result of complete recurrent laryngeal paralysis and cites the following observations:

Kressner refers to the intracranial section of the bulbar root of the accessory nerve which was followed by paramedian position. Influenza may produce paralysis in paramedian position (Fabbi). The same condition was observed after serum anaphylaxis by Seebohm. In discussing several cases of bulbar pathology, Berendes points out that lesions of the caudal part of the nucleus ambiguus affect the bulbar roots of the accessory nerve, which easily explains the paramedian position in such cases. The same rule is confirmed by Luchsinger's 91 cases of laryngeal paralysis following thyroidectomy: 83 paramedian and 8 intermediate positions. O. H. Meurman published 161 observations; 111 cases (69%) showed paramedian position, while intermediate position was noted in only 50 (31%) cases. By proving the atrophy of all intrinsic muscles, Oltersdorf demonstrated that paramedian position is the result of complete laryngeal paralysis. Moser [41,42] found all laryngeal muscles atrophied in a case of paramedian position of bulbar origin, although the abductors were most affected.

Contrary to these facts Kl. Vogel retains the opinion that paramedian position does not represent a complete paralysis, but indicates the persistence of adductor function. In this connection it must be remembered that the visual distinction between paramedian and intermediate position may be difficult. Kressner therefore considers the inclination of the cricoarytenoid joint. A horizontal joint axis favors median position, whereas a steeply inclined joint axis causes the cords to rest in intermediate position. Some disagreements may therefore be due to individual peculiarities of anatomic structure.

An important contribution to the problem of terminal ramification was recently made by Gisel and Pichler.[19] They found an extralaryngeal division of the recurrent nerve into a thin, posteromedial sensory branch to the sensory ansa Galeni; the thick, anterolateral motor branch led to all intrinsic muscles. These findings confirm the view of A. F. Williams.[69] They also explain why section of this motor ventral end branch leads to paramedian position: It causes complete paralysis of all intrinsic muscles.

An additional influence of sympathotrophic impulses is suggested by the experimental results (in cats) of Hartenau and Schwetz [23]: Section of one recurrent nerve and of both superior thyroid arteries produced permanent median position of the affected cord. Kecht [33] stresses the significance of reflex factors. He was able to observe a widening of the glottis from the paramedian to the intermediate position by the suppression of proprioreceptive reflex innervation, such as during local surface anesthesia, blockade of both superior (internal) laryngeal nerves, or by deep general anesthesia. This anesthetic relaxation of the adducted cords appears to overcome temporarily the constant spasm of the adductors, particularly of the external tensors.

III. Phonetic Stage of Flutter Voice or of Typical Paralytic Dysphonia.—Paramedian position causes incomplete closure of

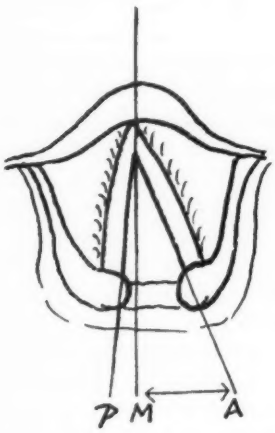

Fig. 4.—Inferior laryngeal nerve paralysis with paramedian position (*P*) of right cord which still shows adequate tension. The left cord moves normally to the midline (*M*).

the glottis (Fig. 4). This means that the normal mechanism of vocal cord vibration can no longer occur. Hence, the voice must be disturbed as described in the third stage of acutely developed laryngeal paralysis. In general, the degree of dysphonia in this stage depends on the remaining tension of the cord, its position, and on level differences between the two cords (Spiess[57]). The main features of vocal disability in this stage are wasting of phonation air, shortened phonation time, diplophony, breathiness or marked hoarseness of the voice, reduction of volume range, loss of volume, and loss of all higher vocal functions.

Occasionally, the voice may also sound quite clear. This is the result of adequate compensation by the healthy cord. Müller[43] saw regular stroboscopic vibrations of both cords in such cases of good compensation. However, the vibrations show a wider amplitude on the side of the paralysis, because that cord is hypotonic. This reminds one of Garde's[18] distinction between hypoexcitable and hypotonic cords. Contrariwise, the visible stroboscopic irregularities increase with the audible roughness of the voice.

Disorders of respiration are encountered less frequently. Since the glottis is wider than it is in median position, there is enough breathing space. Upon severe exertion dyspnea may develop. If stridor is present, it is due to the formation of abnormal air eddies around the flaccid cord, which may also be flopping up and down with a rhythmic noise. Any accumulation of mucus will produce noisy râles, particularly during sleep.

IV. Laryngoscopic Stage of Intermediate Position.—Since we arrived at a distinction between the phonetically well-compensated median position and the paramedian position with manifest phonic disturbances, the previously so-called third stage of laryngeal paralysis (with intermediate position) now belongs in a fourth class. This appears more logical, from a pathologic viewpoint, as well as with regard to the classification of the resulting vocal disorder.

Semon explained the intermediate position as the result of a complete loss of all adductor function. In addition, there appears a visible atrophy and wasting of the paralyzed cord due to the loss of trophic innervation. A similar opinion is expressed by Yannoulis,[70] who also interprets the intermediate position as a sign of complete laryngeal paralysis. In cases of chronic paralysis he demonstrated the atrophic state of the cord in the tomograph. The classic view is further retained by Gregg,[21] who experimentally observed lateral position (in dogs) after section of the so-called "adductor" branch, while interruption of the entire recurrent nerves was followed by intermediate position. An analogous opinion is shared by Hartenau and Schwetz,[23] who noticed a shift of the median to the intermediate position three to five weeks after section of the recurrent nerve (in cats). Again, we notice a discrepancy between human observations and experiments on animals.

The modern view favors the interpretation of intermediate position as the correlate

Fig. 5.—Total and combined paralysis of both laryngeal nerves with intermediate position (*I*) of the bowing, flaccid, and lowered right cord, and with the prolapse of its arytenoid. The left cord moves normally to the midline (*M*).

of *combined and total paralysis* of both the superior and inferior laryngeal nerves (Fig. 5). Sufficient evidence for this concept was presented in the preceding paper. Berendes [9] cites the following observations:

In a case of herpes zoster with affliction of the nodose ganglion and the superior laryngeal nerve Schwetz observed intermediate position of the paralyzed cord. For a long time it was noted that the associated nerve lesions at the level of the jugular foramen, that is, the syndromes of Tapia, Avellis, Schmidt, Vernet, Collet, Villaret, or Garcin, include the signs of total and combined laryngeal paralysis with intermediate position. Since they all denote a lesion above the exit of the superior laryngeal nerve, they tend to prove the influence of its paralysis on the intermediate position. Similar observations were made by Kecht, who found intermediate position in cases of high lesions of the vagus, whereas vagal injuries below the separation of the superior laryngeal nerve resulted in paramedian position. Berendes [9] himself generally correlates intermediate position with the combined and complete paralysis of all vocal cord muscles, that means of the intrinsic muscles and of the external tensor.

Since, then, the hitherto controversial interpretation of an intermediate position centers around the question whether or not a paralyzed cord can shift from a previous paramedian position to the intermediate line of partial abduction, it may be helpful to recapitulate some further opinions. As previously stated, a median shift from incipient intermediate position is relatively frequent. However, the opposite change from median to abducted position is definitely rare.

New and Childrey [49] have never seen it at all; neither did O. H. Meurman. According to Hofer and Jeschek,[25] such a shift should occur when a slowly progressing lesion first affects the recurrent and then also the superior laryngeal nerve. Jeschek was later able to demonstrate this possibility in the case of an esophageal cancer. At first the affected cord was found in paramedian position; later it stood in intermediate position. Autopsy: vagus and recurrent nerve were totally destroyed, the tumor reached the external branch of the superior laryngeal nerve, and the cricothyroid muscle was atrophic. Homolateral palatal paralysis proved the presence of retrograde degeneration. I remember a very similar case of esophageal carcinoma which was first diagnosed when the patient complained of hoarseness due to laryngeal paralysis with paramedian position. Being inoperable, he received radiotherapy and later developed total aphonia due to intermediate position. Tschiassny [66] shares the modern view by proving that a reflex contracture of the cricothyroid muscle can be relieved with local or nerve block anesthesia, as long as the joints remain movable.

All evidence thus points to the cricothyroid muscle as being responsible for retaining the cord in a paramedian position. Whenever this adducting action of the superior laryngeal nerve is abolished, by progressive nerve lesion or by local anesthesia, the cord may very well move laterally to the semiabducted intermediate position, provided the arytenoids remain movable.

We must therefore conclude that a shift from the paramedian to the intermediate position is possible and then represents a progressive nerve lesion.

IV. Phonetic Stage of Severe Dysphonia.

The possibility of lateral shift being established, it is now easier to understand why the voice should deteriorate in this stage of a progressive lesion. With the advancing loss of all vocal qualities the voice gradually decays to a degree of hoarseness similar in severity to that we have found in the second stage of an acute lesion. This is not surprising, since the atrophic, bowing, and lowered cord in intermediate position fails to establish any glottal closure for phonation. As a direct result the air waste is great, shortening the phonation time, causing polypnea, and reducing the vocal volume. Since the abducted cord can hardly partake of vibrations, the voice sounds extremely hoarse, noisy, and breathy. Müller [43] noticed the stroboscopic standstill of the abducted cord, while the healthy cord vibrated in a more vertical direction. Vocal range is reduced to one or two noisy tones in the center of a blurred middle register, with resulting monotony of the speaking voice.

Respiration, on the other hand, improves as the glottis becomes wider. Hence, all signs of dyspnea disappear, and the subjective shortness of breath is limited to the polypneic speaking efforts. However, the loss of glottal closure interferes with the reflex functions of the larynx, so that coughing, clearing of the throat, expectoration, and abdominal straining are disturbed. This may lead to bronchitis, constipation, or cardiac complaints.

V. Laryngoscopic Stage of Crossed Arytenoids.—The crossing over the midline of the healthy cord and its arytenoid is well known since the time of the classic authors. Semon called it the final or fourth stage of a progressive lesion. This phenomenon is generally interpreted as an act of compensation by the healthy cord, particularly under the influence of the bilaterally innervated interarytenoid muscle.

As will be explained in a subsequent paper, the intact cricothyroid muscle tends to rotate the glottis in such a way that the posterior commissure is shifted over the midline towards the side of the paralysis. Since the additional paralysis of the superior laryngeal nerve is now regarded as the main factor in producing the intermediate position of a paralyzed cord, it is most plausible to assign the crossing phenomenon to the unilateral action of the healthy cricothyroid. The exact mechanism of crossing depends on the positional change of the paralyzed arytenoid. When this cartilage is prolapsed forward as in Figure 6, the intact arytenoid must cross from behind, bringing the vocal process of the normal cord in contact with the paralyzed arytenoid *(posterior crossing).* If, however, the paralyzed arytenoid has fallen backwards, the healthy cartilage crosses in front of it *(anterior crossing).*

As a rule, the paralyzed arytenoid is *prolapsed forward,* a position which is explained by its muscular attachments (Jackson, Ballenger, Lederer). There appears to

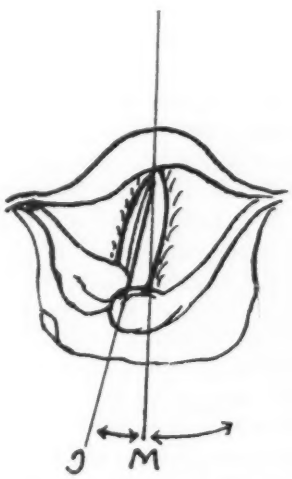

Fig. 6.—Total and combined paralysis of both laryngeal nerves with compensatory overadduction of healthy left cord and posterior crossing of left arytenoid.

be general agreement that the arytenoid is normally braced backwards by the posterior cricoarytenoid muscle. Hence, its paralysis will allow the other muscles to pull the cartilage forward. In the case of total paralysis, such forward pull is exerted by the weight of the cord and its intrinsic muscles. Again, the precise direction of prolapse is determined by the inclination of the joint axis (Kressner). According to Jeschek,[28] the forward pull in the paramedian stage is effected by the intact cricothyroid muscle. Berendes[9] further quotes Y. Meurman's observation of a flaccid prolapse which disappeared during supine position. This fact reminds one of Schlesinger's[2] test for the differention between active and passive rhinolalia aperta; the latter decreases during reclination, being due to flaccid paralysis of the soft palate.

Undoubtedly, the paralyzed arytenoid may also fall in a *dorsal direction.* If we remember the rare cases of physiologically crossed arytenoids as a sign of a harmless laryngeal malformation, it is not difficult to understand why a congenital peculiarity in the articular anatomy may cause an anterior crossing. However, there must also be other reasons for the paralytic anterior crossing, for it is more frequent than is the physiologic crossing.

V. Phonetic Stage of Partly Compensated Dysphonia.—As soon as the crossing healthy cord makes the glottal closure more efficient, the voice improves again. It becomes louder and somewhat clearer, although it continues to sound breathy, weak, easily fatigued, and polypneic. Further phonic signs are the sudden breaks to a falsetto voice or, in other cases, the intermittent changes to the flutter voice. Diplophony may then be caused by the consonance of a higher tone, or by the sudden change between two varying pitches. Again, the speaking range may be too high, because erroneous efforts at vocal compensation increase the tension of the healthy cord and drive the pitch upward. In this manner the vocal characteristics are reverting to the third stage of flutter voice.

A further progression to a stage of *complete aphonia* is rare in unilateral paralysis. It cannot be explained by the condition of the paralyzed cord. Rather, it is then due to the secondary or psychologic complications of poor motokinesthetic control, lacking audiosensory attention, psychoneurotic tendencies, general physical weakness, old age, and the like. In the rare condition of bilateral laryngeal paralysis with abducted position of one or both cords it is easy to explain total aphonia on an organic basis.

Respiration usually remains undisturbed, since the crossing arytenoid allows for a sufficient breathing space during its respiratory abduction.

Phonetic Signs

The sequence of phonic disturbances from the viewpoint of laryngeal pathology having been described, it is equally revealing to discuss the single qualities of the voice as they are changing from one stage to the other. Summarizing the above presentation, we arrive at a table which illustrates the views of Stern,[58] Döhne,[13] and Arnold.[2] These appear to be widely accepted by European writers (Table). In this respect a recent report by Jeschek[31] merits attention because he drew attention to the normal sequence in the function of the adductor muscles for the performance of adduction. According to this author there exist variations in this sequence, depending on the momentary phase of such sequence.

If we attempt to describe the typical and usual changes of the vocal qualities as they can be correlated with the various stages of laryngeal paralysis, we must bear in mind that exceptions to these rules are not infrequent. Quite often one finds discrepancies between the laryngoscopic and phonetic findings. Either the voice may be worse than should be expected from the appearance of the vocal cords; or one may be astounded to hear a good speaking voice,

Course of Vocal Disability in Unilateral Recurrens Paralysis

	Phonetic Stages					
	Aphonia	Severe Dysphonia	Flutter Voice	Slight Dysphonia	Compensated Voice	Atypical Courses
A. Sudden onset	I Usual	II Always	III Always	IV Frequent	V Rare	(a) Spontaneous compensation (b) Falsetto voice (c) Ventricular dysphonia
B. Chronic course	V	IV	III	II	I	
Laryngoscopic Stages						
I. Abductor paresis	Never	Never	Never	Rare	Usual	
II. Median position	Not organic	Rare	Occasional	Usual	Frequent	
III. Paramedian position	Not organic	Rare	Occasional	Frequent	Rare	
IV. Intermediate position	Not organic	Frequent	Usual	Never	Never	
V. Phonatory crossing	Not organic	Rare	Usual	Occasional	Never	

Typical course
Atypical course

while subsequent laryngoscopy demonstrates a poorly closing glottis. In the first case we are wont to assume poor compensation as a result of motor deficiency, psychoacoustic debility, or psychogenic overlay. Conversely, the latter cases seem to be due to an unusually good spontaneous compensation. As a rule this is probable in young, alert, and energetic persons whose thyroid cartilage is not yet calcified and therefore lends itself to the compensatory movements of the extrinsic musculature. Any compression of the thyroid wings by the external neck muscles will produce an approximation of the vocal cords and thus a better glottal closure.

One should also bear in mind that the protrusion of the tongue for laryngoscopy causes a considerable alteration in the shape of the supraglottal resonators and in the position of the larynx. This explains the fact that often a better voice is heard during normal conversation than during laryngoscopic examination. In such cases further clarification may be achieved by laryngeal endoscopy with closed lips, such as with Flatau's endoscope, or with a regular nasopharyngoscope introduced through the mouth. It may then be seen that the cords move more normally during endoscopy than they do while the laryngeal mirror is being used.

Incidentally, the opposite observation of a better voice during laryngoscopy in a case of poor speaking voice suggests the presence of a habitual or psychogenic dysphonia and tends to rule out a purely organic cause of such dysphonias.

1. The general *sound* of the voice varies with the vocal cord position. Correspondingly, it is more or less hoarse, rough, harsh, rasping, or cracking. This is due to the lacking or irregular vibration of the paralyzed cord, as can be well seen with the stroboscope. While this cord shows no vibration at all in the stage of aphonia, it partakes of the bilateral vibrations as soon as compensation has set in. Whenever the glottal closure is deficient, the paralytic cord shows the following type of abnormal vibration. After a brief period of incipient vibration with bilateral horizontal movements, the weak cord loses contact with its partner and begins to flutter. Finally its vibrations decelerate, become aperiodic, and show a vertical direction. This asymmetry of vibration fosters diplophony. Otherwise, this acoustic symptom may be due to the appearance of higher or lower side tones which are produced by abnormal air eddies below or above the bowing cord. Sometimes diplophony occurs with the quick alteration of pectoral and falsetto resonances.

2. Changes in *breath volume* are well known since Döhne's [13] exact studies. As long as aphonia persists, the air volume used for attempted phonation approaches the values of vital capacity. During severe dysphonia it is four to five times higher than normally. The flutter voice consumes about three times the regular volume and even in the stage of slight dysphonia the air consumption remains doubled. Döhne explained this fact (first) with the increased opening quotient due to the diminished tension of the affected cord, (second) with the compensatory elevation of subglottic pressure, and (third) with pathologic aerodynamic actions. According to Bernoulli's law, which was introduced into phonic physiology by W. Tonndorf,[64] an insufficient glottal closure will reduce the aspirating action on the vocal cords by the escaping air stream.

3. *Vocal intensity* is reduced in direct proportion to the amount of wasted air, and thus remains proportional to the diminished subglottic pressure.

4. *Speaking pitch* varies widely with the individual stages of vocal disorder. It is indeterminable during the stage of aphonia, since the whispered utterances have no tonal quality. During the stage of severe dysphonia the average speaking range is usually lowered by a few semitones. As soon as the stage of flutter voice is reached, the speaking pitch rises frequently above the average norm and may even ascend to the middle register, which is of course much too high in men. Döhne suggested an explanation for this fact. As a result of the shortened length, diminished diameter, and reduced specific weight of the paralyzed vocal cord, its mode of tension is permanently altered and cannot be compensated for except by increased external tension. Obviously, this tension can be exerted only by the cricothyroid muscle, which, in addition, serves to equalize the incomplete fixation of the arytenoid. Until a stage of sufficient compensation has been reached, this overexertion of the external tensor raises the pitch of the speaking range. In the case of slight dysphonia the speaking range tends to be normal as a significant sign of good compensation. The same is true for the completely compensated voice.

5. The *vocal range* is always considerably reduced so that only a few tones are available in many cases. This causes the poor modulation and the monotony of the paralytic voice. Similar to the lowered median speaking range, the reduced vocal range in the stage of severe dysphonia is due to the decreased function of the external tensor. This muscle cannot exert its full function unless the vocal cords are supported posteriorly by the arytenoids. This is not the case whenever the paralyzed arytenoid is in a prolapsed position. So long as the healthy vocal cord adjusts to the vibration of the paralyzed and flaccid cord, adequate phonation remains possible on a limited low pitch. Whenever the tension of the healthy cord increases as a result of increased air pressure or greater vocal effort, the voice tends to jump into the falsetto register.

In general there is a relationship between the degree of the dysphonia and the range of the voice, as was verified by Döhne.[13] The author found an average range of 5 to 6 semitones during the stage of severe dysphonia; 11 to 12 semitones in the stage of flutter voice; 16 to 17 semitones in cases of slight dysphonia; and an average range of 19 to 20 semitones after vocal compensation had been achieved. As can be seen, the range of a compensated dysphonia remains considerably reduced, compared with the normal average of 30 to 36 semitones. Naturally, these average values should be understood as a general orientation since individual variations are quite frequent during all paralytic stages.

6. The *vocal registers* are narrowed and displaced in relation to the residual vocal range. Their passages appear considerably disturbed and displaced. In the stage of severe dysphonia the general hoarseness usually abolishes all register differences.

Such a weak and limited voice is therefore reduced to *one register*. During the stage of flutter voice one usually hears a vague, or occasionally an abrupt, transition between the weak chest voice and a thin falsetto register. Such sudden transitions are generally explained by the organic tendency of an oval and bowing glottis to favor the use of the falsetto voice. Quite frequently the head voice is missing, particularly when the superior laryngeal nerve is also paralyzed. Nadoleczny [46] observed the full return of the head voice only in those cases whose vocal disability could be completely cured. In some of our cases we noted a total recovery of vocal cord motility. Vocal therapy had achieved a normal speaking voice. Nevertheless, the vocal range remained limited because the head voice did not return. One of our patients could not sing higher than to the tone f = 175 cps, although his visible paralysis had completely subsided. For this reason he had lost the ability to sing, to call aloud, and to scream. Further vocal therapy during a few months enabled him to widen his vocal range to middle c = 261 cps. It can thus be seen that *two registers* may be present for two reasons: either because the middle register between the chest register and the falsetto voice is absent, or because the head voice has been lost. *Three registers* are found only in the stage of slight dysphonia or after full compensation of the vocal disability.

7. *Phonation time* is frequently reduced to a few seconds and usually corresponds to the degree of dysphonia. However, it often remains considerably shortened even in cases of well-compensated vocal disability, apparently as a sign of decreased vocal cord tension. The explanation for this fact is given by the previous considerations.

8. *Discrepancies* between the degree of the vocal disability and the visible laryngeal findings are frequently due to poor intralaryngeal compensation. As previously discussed, compensation may be delayed owing to poor motor coordination or as a result of insufficient psychoacoustic talent. In such cases one may find aphonia, falsetto voice, ventricular dysphonia, or another type of habitual hyperkinetic dysphonia. Some patients try to overcome their hoarseness by increased vocal effort. Consequently, they may overcontract the external tensor, and thus develop a constant falsetto voice. It is interesting to note that such predominantly functional complications of a primarily organic vocal disability may persist even after the full recovery of all laryngeal movements. Emotionally unstable persons sometimes retain certain pathologic movements of phonation on a habitual or emotional basis long after all visible signs of a previous laryngeal paralysis have completely disappeared.

9. *Functional complications* on a habitual or emotional basis were particularly frequent in times of war. During normal periods they may be associated with medicolegal problems or with endocrine imbalance. In such cases no agreement is found between the degree of vocal disability and the disturbed laryngeal motility. It is not difficult to recognize such functional overlays if we remember certain basic laws of laryngeal function. Thus, the voice may be much better during laryngoscopy than in the course of spontaneous conversation. Another psychogenic discrepancy may consist in the difference between a relatively good singing voice and a severely disturbed voice for speaking. Such observations demonstrate the fundamental difference between thalamic and cortical regulations of phonation. Finally, the sign of well-preserved reflex phonation, such as during coughing, is always highly suggestive of a psychogenic disorder which affects primarily the conscious and voluntary efforts of vocal communication.

10. As an illustration of the *relative frequency* of the various phonetic stages, the analysis of 205 cases of laryngeal paralysis observed by me from 1939 to 1945 appears quite typical: organic aphonia 38;

severe dysphonia 57; flutter voice 49; slight dysphonia 23; falsetto voice 17; psychogenic hypokinetic aphonia 12; psychogenic hyperkinetic dysphonia 9. No cases of functionally compensated voice were then registered, simply because they did not need any voice rehabilitation in the first place. However, complete functional compensation is the goal of vocal therapy and can be achieved quite frequently if all circumstances are favorable. This will be discussed in a subsequent paper.

Summary

All observers agree that the type and degree of vocal disability due to laryngeal paralysis is quite variable. One encounters all degrees from total aphonia to minimal limitations of the trained singing voice. Type and onset of laryngeal paralysis determine a basic difference between the cases of acute onset and of chronic progressive course.

Acute onset is characterized by five consecutive stages of vocal disability. It usually begins with complete aphonia and may revert to a stage of compensated dysphonia or to full recovery under favorable circumstances. Chronic progressive lesions show the opposite course from an initial stage of compensated voice to variable degrees of severe dysphonia. An attempt is made at correlating the five laryngoscopic stages of visible paralytic signs with the five phonetic stages of audible dysphonia.

In a subsequent analysis of the phonetic signs of paralytic dysphonia the single vocal qualities are discussed and followed through the five stages. It can be seen that all audible phenomena of paralytic dysphonia are determined by the acoustic laws applicable to an abnormal laryngeal sound generator. They are in good agreement with the classic myoelastic theory of phonation.

Whenever a deviation from the general relation between the visible and audible findings is encountered, such discrepancies are due to secondary psychomotor or psychoacoustic interferences with spontaneous or therapeutic intralaryngeal compensation. Similar explanations apply in cases of functional complications of the basic laryngoplegia by additional psychogenic disorders.

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The "Maxilla-Premaxilla" Approach to Extensive Nasal Septum Surgery

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The total submucosal removal of the nasal septum and all less extensive operations present a common technical difficulty. This is the elevation of the mucosa over obstructing and impacting cartilage and bony ridges and spines, especially if these are in the anterior area about the caudal end of the septal cartilage, the premaxillary wings, and the maxillary crests. Failure to identify and include in the elevation the whole of the periosteal and perichondrial layers makes further separation of the mucosa uncertain and difficult and leads to incomplete correction and early or late perforation formation.

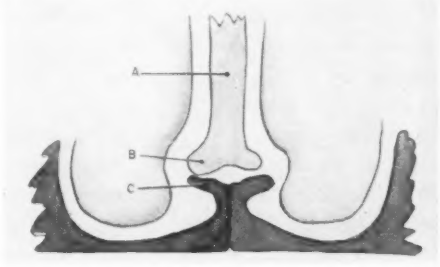
Correction of the anterior (caudal) portion of the septum is very frequently of prime consideration and its preservation or replacement is particularly essential in septum operations combined with pyramid surgery and when a careful reconstruction or reorganization of the os internum is necessary.

Anatomical Considerations

The septum cartilage in the white adult averages 3-4 mm. in thickness and in general has its surfaces parallel. The anterior portion of its inferior or ventral border, however, is not this way. Here the cartilage extends laterally for 2-4 mm. on each side to form a footplate 4-8 mm. thick. These lateral extensions were described by Zuckerkandl[1] and named the "processes laterales ventrales." Similar lateral extensions of the cartilage frequently are present dorsally (anteriorly) and serve for attachments to the roof (upper lateral) cartilages. They might be referred to as the "processus laterales dorsales."

Posteriorly the septum cartilage is held firmly to the nasal bones, the ethmoid plate, and the vomer by close intimate fibrous bonds. In the last two the bonds arise from their embryologic derivation in the membranous sheath of the fetal septal cartilage. The anterior-inferior (caudal) border of the cartilage is attached to no bone or cartilage but lies in free contact with the membranous septum. Behind this the inferior border has well-developed processus (laterales ventrales) and rests on the correspondingly flared-out wings of the premaxillary bones (Fig. 1). This rather broad cartilage footplate and its appropriate bony pedestal are held in close approximation by fibrous tissue but are not fused into a single unit. The cartilage is enveloped by a perichondral and submucosal fascial sheath which extends around and under

Fig. 1.—Diagram of frontal section through anterior portion of septum. *A*, septal cartilage. *B*, processus lateralis ventralis. *C*, wing of premaxilla.



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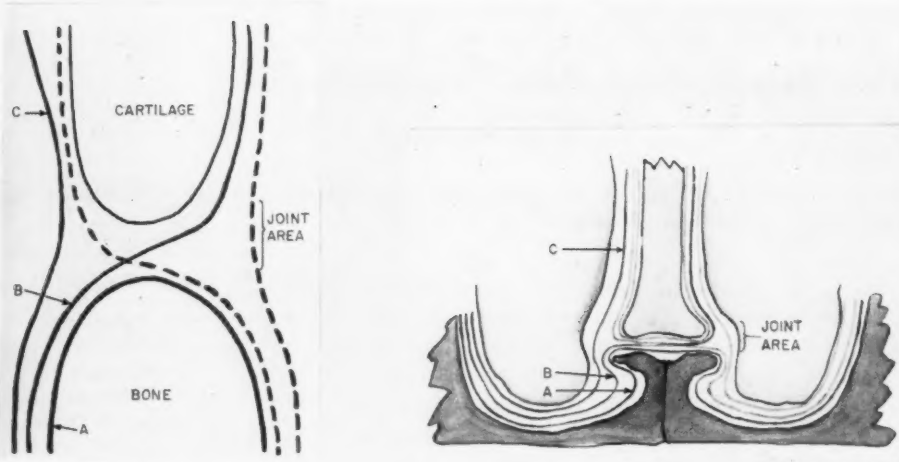


Fig. 2.—Left, lines indicate periosteal or perichondrial fibers enveloping cartilage or bone *A* crossing to opposite side *B* or crossing joint area to same side of other *C*. Right, Figure 1 and Figure 2 superimposed.

the cartilage from one mucosa to the other. This sheath, therefore, separates the cartilage completely from its bone support inferiorly and also from a too intimate connection with the membranous septum proper. The premaxillary and the maxillary crest similarly are covered by fascia consisting chiefly of periosteum and supporting connective tissue. It has been shown, however, that some fibers of each envelope do cross over to join with adjacent fibers, to make a joint-like capsule. Some stay on the same side and some extend through the joint area to the opposite side (Figs. 2 and 2a). Fat particles have been identified in the contact region, thus strengthening the concept that the septal cartilage (anteriorly) and the underlying bone form a true joint permitting movement and motion.[2]

The terminal 6-10 mm. of the upper lateral cartilages attached to the septal dorsum by soft tissues lined by the nasal mucosa, thus allowing for valve action of the upper laterals and freedom of movement of the caudal end of the septum. It is most noteworthy that the anterior-inferior corner of the upper lateral cartilage in the white adult does not join the anterior-inferior corner of the septum but remains about 5 mm. posterior. Similarly in the Caucasian the anterior nasal spine does not extend anteriorly as far as the septal cartilage does. Frequently the cartilage is a centimeter in front of the acanthion, again establishing room for less impaired movement.

In the adult Negro and young white person the caudal end of the septum is not so well grown and thus is in closer relationship to the ends of the nasal spine and the upper lateral cartilages.[3]

Etiological and Pathological Considerations

From birth a white man's nose is subjected often to much nasal trauma. Six to seven per cent of all normal births in the white race produce an obvious deformity of the nose. Thirty to sixty per cent have a flattening of the nose, which, however, soon regains a more normal appearance. Added to this are the innumerable minor and major nasal injuries, which altogether make trauma to the external nasal pyramid the most frequent injury sustained by man.

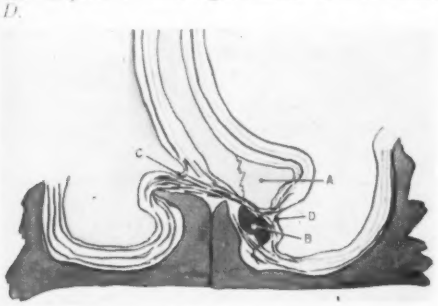
We are very concerned in this thesis with the effect of these traumata on the chondro-

osseous joint of the septum and a method of approach to the area for surgical correction of the resulting deformities and functional disorders.

Very frequently the joint capsule is ruptured, in part or completely, and the septum cartilage broken and/or dislocated downward. In over 60% of patients this occurs in the left nasal chamber and is often accompanied by fracture displacement of the premaxillary wings or body and the maxillary crests (Fig. 3). Many varied forms of traumatic or developmental deformities occur. Just a few are illustrated (Fig. 4). If the original injury was sustained in infancy or early childhood, there will often be seen an asymmetry of the floors of the pyriform apertures. On the side of the septal obstruction the floor may be from 3 to 7 mm. above the other side, making the already smaller os internum even more crowded. Another occasional finding is a long narrow segment of curled cartilage lying on one or both sides of the lower part of the septum. Separating it from the anterior two-thirds of the septum is usually easy, but posteriorly it may be firmly attached to a spine or ridge of the vomer. We believe that in all likelihood such a cartilage is a persistent paraseptal cartilage, a vestige of a constant embryological structure (Fig. 5).

Submucosally the injury has also exacted its toll. The connective tissue fibers enveloping the cartilage and bone and those which extend between the two mucosal flaps have been torn. Bleeding has also occurred in the torn tissues. With subsequent healing and scar formation the two mucosal flaps are firmly bound together and their surgical separation becomes increasingly more difficult (Fig. 3).

Fig. 3.—Cartilage subluxated and fractured *A*, wing of premaxilla fractured and displaced *B*, scar in joint *C* binds right mucosa to left mucosa *D*.



In addition, each piece of cartilage and bone that has become separated or broken off completely from its place of origin develops its own scar tissue encapsulation. When such pieces become interwoven and intermixed with the original and newly formed connective tissue fibers, a challenging complicated situation is created.

Historical Considerations

Many of our distinguished colleagues in the past have grappled with the problem described and have contributed much that we can use and apply today.

Mosher [4] displayed the disturbed anatomy of the premaxilla and the association with other septal deviations and obstructions. Yankauer [5] illustrated the dense fibrous separation between the septal cartilage and bone. Metzenbaum [6] demonstrated a method of surgical correction applicable to many deformities of the caudal portion of the septum. More recently Klaff [7] and others have added to the mounting knowledge, but the problem is still with us. When the very essential task of correcting the anterior deformity seemed to be under control, it was soon learned that the very correction produced complications and sequelae of importance equal to and sometimes greater than the original problem.

Among these sequelae the following must be listed:

1. Sagging of the cartilaginous (lower) half (or more) of the nose
2. Saddling of the cartilaginous dorsum
3. Broadening of the base of the lobule
4. Retraction and collapsing of the columella
5. Widening and flattening of the nostrils
6. Ballooning out of the valves (upper lateral cartilages)

Other important complications seen not too infrequently are the following:

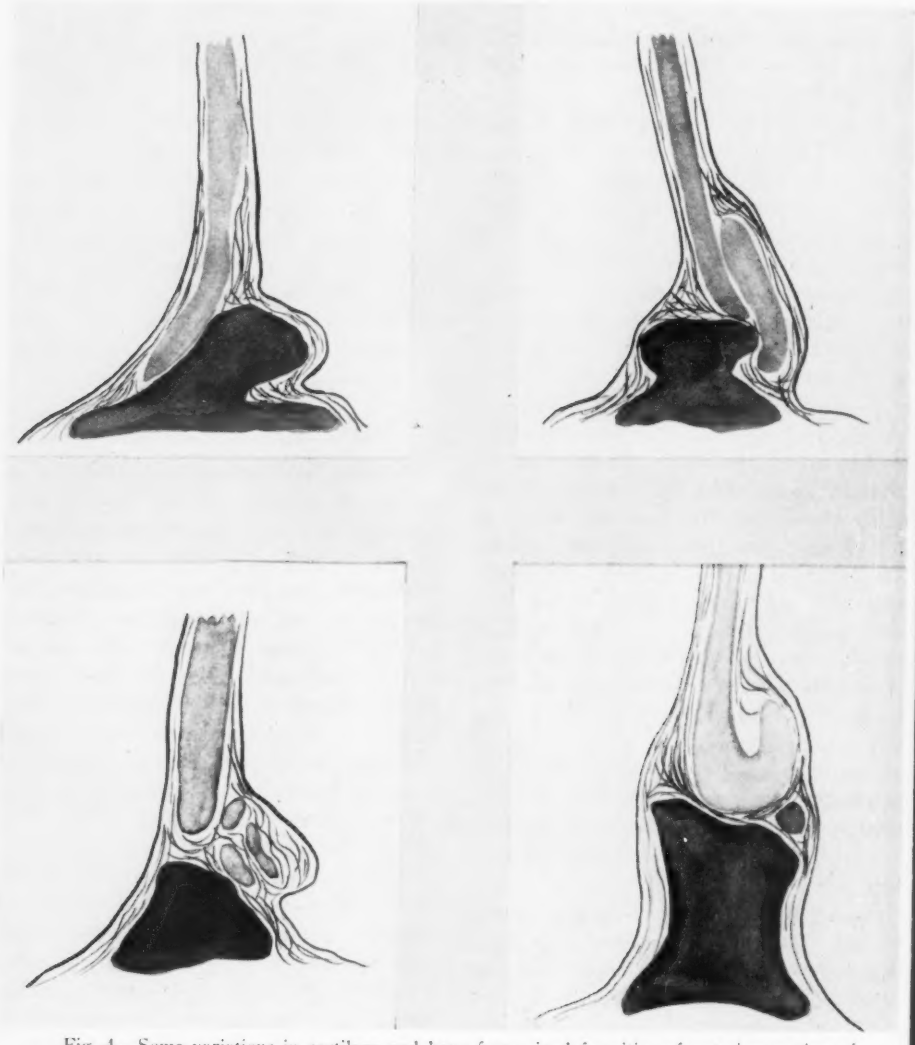
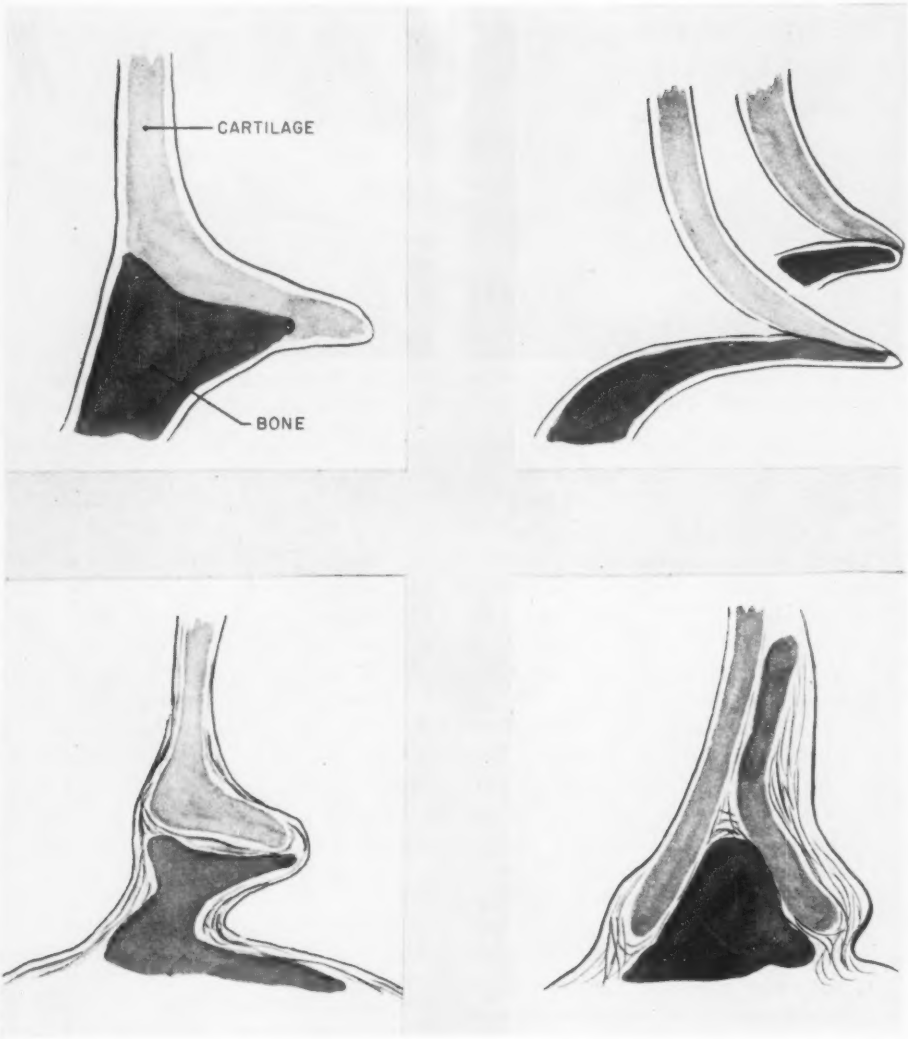


Fig. 4.—Some variations in cartilage and bone forms in deformities of anterior portion of septum. (Continued on opposite page.)

1. Perforations of the nasal septum
2. Marked linea nasalis
3. Absence of nasal spine
4. Allergies
5. Atrophy of some or all of inner and outer parts of the nose
6. Disturbances of function of nose, and also of other organs
7. Fatigue and emotional upsets
8. Skin changes

All of these problems imply an involvement of any or all portions of the nose, and the indicated surgical objectives can be considered in three parts.

1. A safe but conservative method of exposure of the whole nasal septum and the structures with which it is in contact and pathologically involved
2. Methods of approach to other deformed structures of the nose which have resulted from injury directly or from subsequent developmental changes
3. Repair and reconstruction of the septum, spine, upper lateral cartilages, pyriform crest, and



the structural elements of the lobule to prevent sequelae that may already be present and/or which appear sooner or later after nasal operations

We shall concentrate chiefly on the technique of exposing the caudal portion of the septum, the anterior nasal spine, premaxillary bones, the crests of the superior maxillae, and the pyriform apertures.

Preoperative Preparation

Children up to the age of 9 years are usually operated on under general anesthesia, the intratracheal method being the one preferred. In adults, the surgical procedures are done under local anesthesia. Some sedation is used the evening before surgery, and one hour before surgery barbital sodium (Veronal) 250 to 500 mg. is given orally. Chlorpromazine (Thorazine) hydrochloride 15 to 50 mg. is administered by mouth about one-half hour before surgery, and has proved to be of inestimable value. At the same time an appropriate dose of meperidine (Demerol)

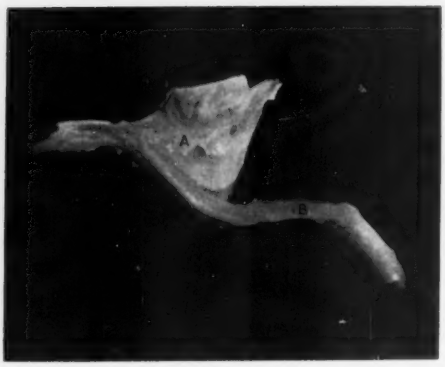


Fig. 5.—*A*, spur of posterior portion of vomer. *B*, paraseptal cartilage.

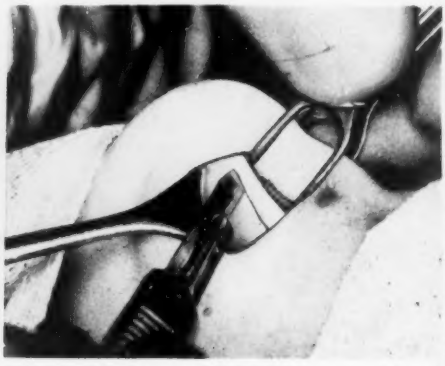


Fig. 6.—Incision ⅛ in. posterior to caudal end of septum.

is administered hypodermically, from 15 to 100 mg. being used according to the age and needs of the patient. Just before the start of the operation chlorpromazine 10 to 25 mg. is given hypodermically and occasionally repeated during the operation. The tranquility of the patient and what might be referred to as the "tranquility of the tissues" are objectives worthy of achievement in the performance of the surgery and give added assurance of the best possible postoperative healing. To this end, also, music, soft, classical, reminiscent, but not too familiar, is offered to the patient via earphones. In a period of over 10 years the music has repeatedly given striking evidence of its tranquilizing value.

The patient is told what he will experience before, during, and after the operation, and some anxiety is thereby relieved.

The vibrissae of the nasal vestibule are trimmed, the mustaches of men are preferably removed, and the face, nose, and nasal vestibules are cleansed with soap and water, alcohol, and ether. Benzalkonium (Zephiran) solutions help in the preparation of the surface skin and the lining of the vestibules. The patient is draped, and the hair of the head well covered with sterile towels. In this way a sterile limited field is made available to the surgeon.

The patient lies more or less flat on the operating table with a little elevation of the head for his comfort. An overhead light should be available, but primarily this operation requires good intranasal illumination, such as provided by a "Good-Lite." Looking through such a light, just as looking through a head mirror, gives the best visualization of the interior of the nose. The surgeon should adjust his light before he scrubs and dons sterile gown and gloves. A good assistant or an experienced nurse is of paramount importance. The patient should be shown how to blow and breathe through a small plastic airway tube in the mouth just before the operation is to begin. This helps prevent a feeling of breathing difficulty and minimizes the effects of nasal vertigo and panic, should they occur.

Operation

The caudal portion of the septum is exposed by traction of the columella and membranous septum downward and to the left. An incision on the right side of the septum is then made ⅛ in. behind the caudal end of the septum down to the cartilage, the traction on the mucosa being maintained throughout the incising (Fig. 6). (Note: A right-handed surgeon should, if at all possible, have the light over his right eye and stand on the right side of the patient and approach this surgical problem through the right vestibule of the patient. Even if the caudal end of the septum is tortuously dislocated into the far

lateral portion of the left vestibule, it is still feasible to operate through the right nasal chamber and on the right side of the patient.) The incision has previously been more fully described.[8] By repeated small strokes of the knife the submucosal fibers are freed until the cartilage has been reached. The caudal border can now be scraped free of fibers with the knife and pulled toward the right with a curved hook. The freed membranous septum is retracted to the left with another hook, and the left side of the septal cartilage is ready for exposure. At this moment the importance of the next step must be underlined. It is absolutely essential that the elevation of the mucosa be done definitely under the perichondrium. Since it is easy to be not quite under this final layer of covering, one must acquire technical assurance that he is in the proper plane for the elevation. We start by scraping the soft tissues from the cartilage in a small limited area with a short, round, stiff, sharp knife-like instrument (e. g., the Cottle knife). One cuts slightly into the cartilage and tries to push back the soft tissues, holding the knife at about 85 degrees to the plane of the cartilage in the direction of the elevation. The actual, though limited, cutting into the cartilage helps find the plane of division even in those instances where much scar has formed as a result of repeated trauma and exposure to faulty air streams and infections. A characteristic sound and feel, a gritty rough resistance, tell of the arrival at the desired level. In the proper plane the cartilage is blue, lustrous, and smooth, while the line of reflection of the mucosa is sharply defined, whitish, and yielding. The maneuver of holding the cartilage to be isolated with a hook in the left hand, and scraping with the right (also applicable to bone) is the best guarantee for preserving all the mucosa that will and can be separated from bone or cartilage (Fig. 7). Whether the bone or cartilage to be removed is fixed to other tissues or free, its separation from soft tissues, scars, and mucosa can best be done in difficult situations with the scraping technique described.

The next procedure is the creation of what we refer to as a left anterior (submucosal) tunnel. With a bent dull-ended elevator one raises the mucosa by hugging the cartilage just exposed with the end of the instrument and with lateral movements gently pushing up and separating the mucosa from the anterior portion of the cartilage (Fig. 8). This must be done under direct vision either by watching the instrument in the operation area (intraseptal) or by looking into the left nasal chamber and seeing the progress of the instrument beneath the nasal mucosa (intranasal). Continuing the mucosal elevation without observation is not to be recommended. As soon as the bone of the septum is reached

Fig. 7.—Cottle knife *A* scrapes left mucosa *B* from septal cartilage *C*.

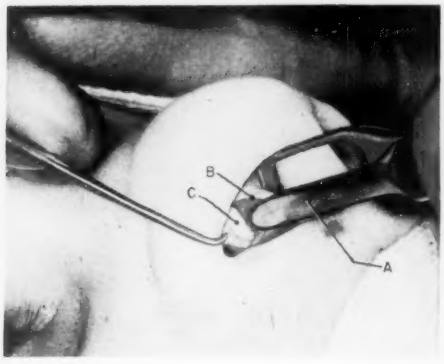
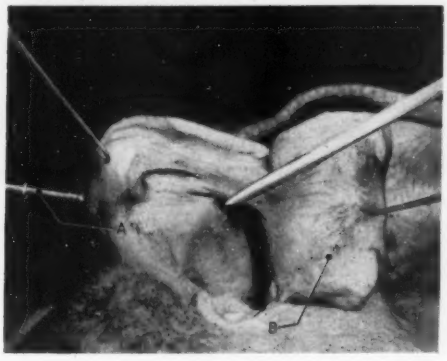


Fig. 8.—Instrument *A* elevates left mucosa (pointer) anteriorly. Left lobule *B* is cut and moved. (For demonstration.)



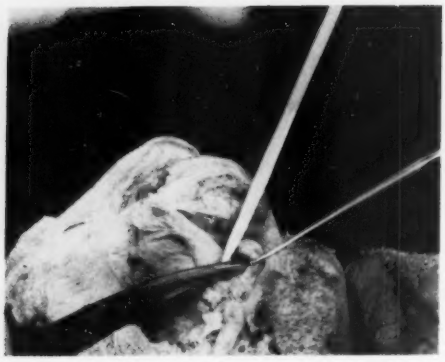


Fig. 9.—Scissors (pointer) through posterior part of original incision enters space between muscles and buccal mucosa. (Undermining base.)

in its anterior (subdorsal) area, a sharper elevator should be used. This again gives a characteristic scratchy sound and feel and will usually not penetrate the perpendicular plate of the ethmoid but instead will give greater assurance of its being in the proper location. When the posterior area is reached, the mucosa is separated some more by bringing the elevator from behind forward and inferiorly and this is continued so long as one can see and feel that separation is safe and not too difficult. This procedure is frequently quite easy in the posterior two-thirds of the septum even when troublesome in the anterior third. It is a good rule at this time (or at any time) not to go on if things are hard to do or see. One can always come back to this or to any other procedure when the situation has changed and probably has also become less complicated.

Maxilla-Premaxilla Approach.—It is usually about this time in very severely injured noses that one discovers himself pressed into an unmanageable arena of scars, fractures, and dislocations. One then welcomes the opportunity to change tactics and to approach the problem from an entirely different angle. For this change of approach the base of the nose is first undermined. To accomplish this, small curved Knapp scissors are placed into the posterior portion of the original incision and with small mincing spreading movements the membranous septum is gently separated and the separation continued under the lip muscles and above the buccal mucosa. The spreading is carried down to the inferior portion of the middle of the upper lip (Fig. 9). With similar movements the scissors are directed laterally toward the left corner of the mouth and then to the region immediately above.

Coming back to the midline, the undermining is continued toward the right corner of the mouth and the tissues above. A 2 in.

Fig. 10.—Left, fascia from left mucosa (pointer) goes around caudal end of septum to right mucosa. Right, scissors help in extending separation of fascia down toward maxillary spine.

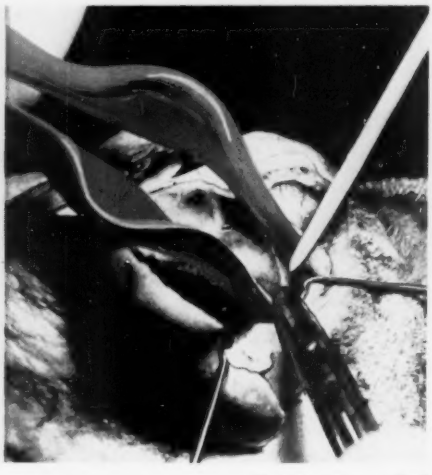
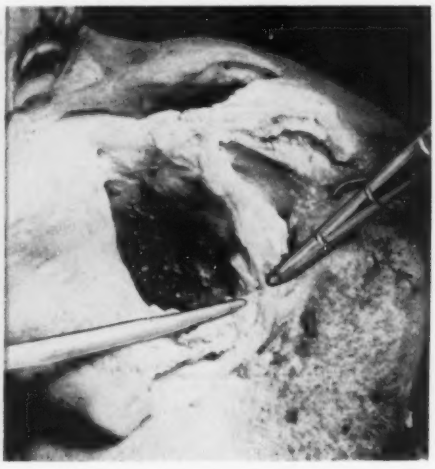


Fig. 11.—Pointing at fascia *A* between undermined base *B* and maxillary spine *C*.

narrow-bladed nasal speculum is now introduced into the midline space just created and the blades separated. Perhaps not more than 3 or 4 mm. of spreading is possible. The fascial fibers which hug the maxillary spine and alveolar processes are connected to the submucosal fibers of the septal mucosal flaps (Fig. 10) and must be separated on each side of the midline. Pushing down the soft tissues with the end of the small scissors just used for the undermining accomplishes this (Fig. 10a). The fascia immediately in front of the spine is still held fast, so the MacKenty elevator is used to disconnect it from the bone. Thus a prespine spread of fascia has been moved from the bone toward the plane of the original undermining (Fig. 11). Some fibers in the midline remain attached, and it is necessary to sever these with a knife. A Bard-Parker No. 15 or a small Beaver blade is adequate for this purpose. This midline cut of fibers extends not only along the full length of the midline of the spine, but should also include the midline of the caudal end of the septal cartilage. When this has been well done, it is not too difficult to scrape and expose the area where the floor and face of the right pyriform crest passes into the formation of the maxillary spine. By scraping this region and exposing the alveolus with the MacKenty elevator, the medial portion of the floor of the crest of the pyriform aperture is felt and exposed and the right nasal chamber is entered submucosally. An elevator, long and sharp, with a small end, hugs the bone near the junction of the floor and premaxillary bone. It will be found that the instrument is not in an anterior-posterior line but actually at right angles to this, pointing inferiorly and anteriorly (Fig. 12). To find this (premaxillary) corner for the beginning of the elevation of the mucosa on the right side near the floor of the nose

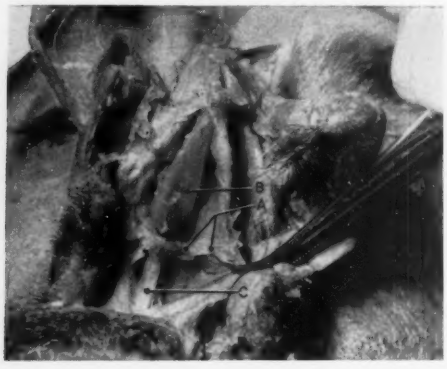
Fig. 12.—Left, elevator in transverse position entering premaxillary corner *A* at start of making "right inferior tunnel." Right lobule *B* moved for visual purposes. Right, instrument assumes anterior-posterior direction as tunneling of mucosa progresses.



is another pivotal objective in this operation. While the procedure is observed through the right nostril, the small sharp elevator is moved backward very cautiously and held near the floor of the nose while it is being moved gradually to an anterior-posterior position (Fig. 12a). Small movements, hugging the bone with the end of the instrument and elevating gently with the little bend which is just behind the end of the instrument, give assurance of a safe nonlacerating progress. The separation of the mucosa on the right side is extended over as much of the bony septum as possible; this means the premaxilla, maxillary crest, palatine crest, and upward in the posterior area onto the vomer and perpendicular plate of the ethmoid. Another tunnel is hereby formed, the right inferior tunnel.

With a MacKenty elevator as much exposure of the left pyriform crest as is necessary and is possible is made and the left premaxillary corner approached with a small sharp elevator. An attempt is made to create a left inferior tunnel, as was done on the right side, and to connect it with the previously prepared left anterior tunnel. These two tunnels usually can be joined with ease in the posterior two-thirds of their extent, but anteriorly a dense tissue separates them and resists strenuously simple methods of severance (Fig. 13). Completing this procedure may often have to be postponed to a time later in the operation.

Fig. 13.—Dense fibrous tissue *A* separates cartilage *B* from bone *C* and traverses joint onto other side.



To review, we now have a more or less extensive separation of the septal mucosa from most of the left side, while on the right we have attempted to preserve meticulously the attachment of all of the cartilage to the right mucosal flap. Beginning with the anterior tunnel on the left, the elevation was expanded into as full a separation as possible, while, after creating the right inferior septal tunnel, the separation of the right flap was limited to the bone inferiorly and posteriorly.

Further mobilization of the septal mucosa on either side is most precarious at this time without recognition of the basic normal and disturbed anatomy present in this area, the anterior portion of the septal osteochondral joint. More or less dense fibrous tissue, often scarred, extends from the left mucosa to the right mucosa underneath the cartilage. This fibrous tissue, it must be repeated, is continuous with the fascia that has been previously more or less completely cut and scraped away from the anterior surfaces of the spine and maxillae; but a portion may remain very adherent to any of the bone structures. It is necessary to cut these tissues. The inferior portion of the anterior part of the septal cartilage is again scraped with a knife to establish the proper subperichondrial plane. With the flat of a small knife one now hugs the cartilage as closely as possible and feels down to the bony plate which supports the footplate of the cartilage. The bone usually cannot be seen or otherwise identified. One must feel for it, and the small knife blade does this with precision. Slowly, a millimeter or two at a time, the fibrous layer is severed in an anterior-posterior direction, the knife being held always on bone. These small repeated cuts, guided by the sense of touch, are accompanied by short scraping movements of the soft tissues towards the left side. A small area of denuded bone eventually becomes evident. Perhaps a little

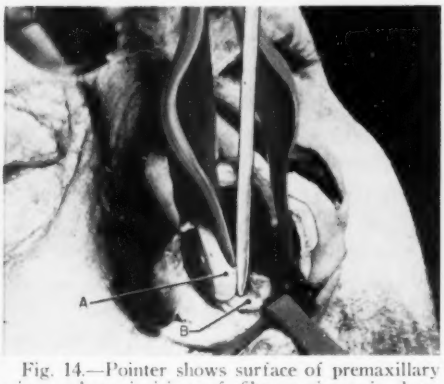


Fig. 14.—Pointer shows surface of premaxillary wings where incising of fibrous tissue is done. Septum cartilage *A* moved off premaxilla *B*.

Fig. 15.—Premaxilla *A* in jaws of forceps. Septum cartilage *B* pushed to right.

more can be done with the knife-scraping technique, and the junction of the left floor of the nose and the anterior-inferior portion of the septum may be visualized. The small sharp-ended elevator can be placed into this spot, and further elevation of the left septal mucosa near the floor of the nose is again assayed. The floor of the left pyriform crest can be further exposed, and, if the cutting of the fibrous tissue has been adequate, a careful scraping with the MacKenty elevator accomplishes much.

It is frequently best at this point to move the septal cartilage from its osseous base. By scraping the cut fibrous tissue from the midline of the premaxillary wings toward the right and toward the previously created right inferior tunnel, the movable caudal end of the septum can be gently dislocated to the right (Fig. 14). More posteriorly the bone and cartilage cannot be separated without some cutting. The cartilage needs to be severed from the bone base as far back as the perpendicular plate of the ethmoid. One then enters the right inferior tunnel, reexamines and further separates if necessary the mucosa from the right of the maxillary and palatine crests.

We now have a mobilized septal cartilage attached to the right mucosal flap and the ethmoid plate, and a complete separation of the mucosa from the right side of the maxillary and premaxillary crests, affording a fine view of these bones. With a 4 mm. chisel the base of these crests (especially anteriorly) is separated from the floor of the nose, and with gentle movements the bone is lifted up and away from

Fig. 16.—Premaxilla *A* crushed and moved to midline. Septum cartilage *B* moved to right.

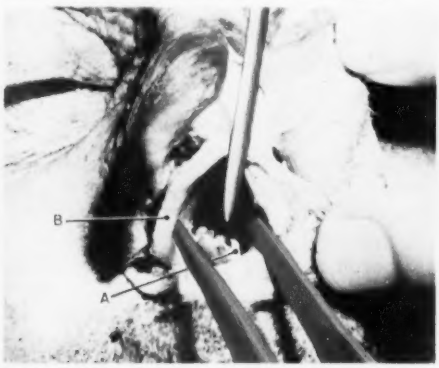
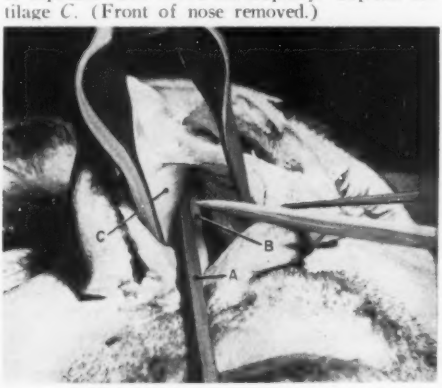


Fig. 17.—Chisel *A* at right of bony septum *B* to separate nasal bones intraseptally. Septum cartilage *C*. (Front of nose removed.)



the left mucosa to which it may still in spots be attached. However, if this does not occur easily the bone may be separated from the left mucosa by further work with the sharp or dull-ended septal elevator or scraped with a Cottle-type knife or a similar instrument.

The premaxillary bones may not be in the midline but may be found dislocated, or one or both wings may be found to be exceedingly flared, sometimes for a distance of a centimeter. With a bone forceps the premaxillary compound may be modified. The wings may be compressed or the bones mobilized and moved back into the midline (Figs. 15 and 16). Partial or complete removal may be advisable.

The posterior portion of the septum cartilage may be separated from the perpendicular plate of the ethmoid with a rounded knife or a sharp septal elevator, or incised perpendicularly just in front of the cartilage-bone junction, and the mucosa over the right portion of the perpendicular plate of the ethmoid and vomer adequately elevated. This separates the whole septal cartilage from its bony contiguities while leaving it still attached in its entirety to the right mucosal flap. In this way access intraseptally to the attachments of the nasal bones to each other and to the bony septum is provided. Through this intraseptal route the nasal bones may be separated (Fig. 17) —medial osteotomies—through their entire extent (or just partially) without injury to the nasal mucosa as it passes from the septum onto the lateral walls of the nose.*

From this point on modification of the septal cartilage in situ can be carried out, bone changes effected, the floors of the pyriform crests, the floors of the nose surgically changed. In the restitution of the os internum of each nasal fossa the septal cartilage attached to the right mucosal flap can be used to the greatest advantage. Further correction of the septum elements should await the mobilization of the external nasal pyramid.

After the pyramid is moved, the septal deformities are frequently changed. Hence a fresh diagnosis of the anatomical and physiological abnormalities of the septum in its new situation needs to be made. Reorganization and reconstitution of the septum, the nasal spine and pyriform aperture, the nasal valves and nasal lobule, together with the correcting of the bony and cartilaginous vaults, are the other elements of extensive nasal reconstruction which need further discussion and correlation.

Summary

Surgery of the anterior-inferior portion of the septum and of extensive septal obstructions is difficult and often results in incomplete correction and early and late complications and sequelae. To perform this surgery with more safety, a method of approach is described which begins with the exposure of the caudal end of the septum, the anterior maxillary spine, and the pyriform crests. Preservation of the cartilage of the septum is emphasized to help retain the function and structure of the os internum. Late sequelae of injuries and surgery of the septum are enumerated to emphasize the frequency of their occurrence.

30 N. Michigan Ave.

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*A short guide for performing this operation on cadaver material has been prepared. Also a list of photographs that may be taken at the same time is available. These are of great value for repeated later study.

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Histological Examination of a Case of Otosclerosis Fifteen Months After Stapes-Mobilization Operation

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Ever since Rosen successfully revived the attempts at mobilization of the ankylosed stapes in otosclerosis the otologists throughout the world have been working on two problems: to develop more satisfactory methods of mobilization and to prevent the reankylosis of the mobilized stapes. Considerable success has been achieved in this respect by purely surgical-clinical research which was greatly aided by our increasing knowledge of the physiology of the sound-conducting system and furthermore by gross anatomical studies of the oval window niche and the adjacent structures. A serious drawback of this approach to the problem lies, however, in the fact that one does not know exactly what is actually happening to the structures involved during mobilization or afterwards.

Detailed histological studies of serially sectioned temporal bones with otosclerotic ankylosis of the stapes, together with a careful evaluation of the findings with regard to the chances of surgical mobilization would unquestionably be extremely useful. They would not only give us a better understanding of the various types of pathology encountered but would also point out the rational way to an improvement of the operative technique. At the same time, such studies could establish the limits of operability of stapedial ankylosis by the direct, transtympanic approach to the focus.

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The histological study and evaluation of 79 temporal bones with otosclerotic changes that seemed to have interfered with the motility of the stapes by Rüedi and Spoendlin are unquestionably a step in the right direction. It is, however, regrettable that the authors did not give a detailed description of the otosclerotic changes in each single case.

The fact that fractures of the stapedial crura and of the footplate do not, as a rule, heal by bony reunion is well known and, we believe, explains the permanency of the hearing improvement in many cases of stapes mobilization. Our knowledge of the biological reaction of otosclerotic foci is, however, practically confined to one single case, reported by Greifenstein. He examined the temporal bones of a patient in whom, under the assumption of a right-sided acoustic neuroma, a translabyrinthine operation had been performed and who died 27 days later. Extensive otosclerotic foci were found in both temporal bones. The operative defect on the right side had penetrated an otosclerotic focus consisting partly of younger (blue) and partly of older (red) areas. Within the younger areas, the defect was completely filled with a dense network of newly formed bony trabecula. They were, as a rule, connected without sharp border with the trabecula of the focus. The bone formation had been preceded by a proliferation of the tissue within the marrow spaces of the otosclerotic focus, which possesses a marked osteogenic potency.

The older parts of the otosclerotic focus presented the picture of a rather compact breccia with a few marrow spaces only.

The operative defect in this area was filled with relatively scanty germinative tissue which had taken its origin from the contents of the opened marrow spaces of the focus. Considerably less numerous and more strongly bluish stained bony trabecula had been formed in this tissue. The newly formed bony trabecula were always separated from the old otosclerotic focus by well-recognizable cement lines.

The regenerative ability of the otosclerotic focus, as of every other bone tissue, depends, according to Greifenstein, on the amount and the functional status in a given moment of the specific germinative tissue present. This fact explains the differences in the regenerative tendencies between the young, spongy, and the older, compact, portions of the otosclerotic foci. In the latter, the intensity of the callus formation is proportionate to the amount and the structure of the tissue in the marrow spaces.

It was our good fortune to get the temporal bones of a patient who had suffered from otosclerosis and in whom a mobilization of the right stapes had been performed 15 months before death by one of us (M. B.).

Report of a Case

A white man, 57 years old, was first seen at the ENT Clinic of Presbyterian Hospital on Oct. 20, 1955, complaining of a hearing loss in both ears of several years' duration and buzzing in his right ear. For the last two months, he had been wearing a hearing aid with satisfactory results. ENT examination did not reveal anything remarkable; his ear drums were normal and the tubes patent. An audiogram taken on Nov. 3, 1955, showed a predominantly conductive type of hearing loss, averaging 65 db. in the right ear and 50 db. in the left ear for the three speech frequencies (Fig. 1). Bone conduction was down to 18 db. on the right and 15 db. on the left for the speech frequencies. The diagnosis of probable otosclerosis with stapes ankylosis was made, and a stapes mobilization operation on the right side was suggested.

The patient was admitted on Dec. 8, 1955, and the stapes mobilization was performed the same day under local anesthesia. A typical Rosen approach was used to expose the middle ear. Some bone had to be removed from the posterosuperior part of the innermost portion of the bony meatus to expose the stapes. The stapes was found to be completely fixed, and indirect mobilization was unsuccessful. The anterior crus was therefore cut with Fowler's scissors. This did not, however, improve the hearing. The lower stump of the anterior crus was then everted anteriorly with a slightly curved needle. At this moment the patient became very dizzy and noticed a sudden improvement in hearing. Unfortunately, no hearing test was made at that time in the operating room. The usual mastoid dressing was applied, and the patient was sent to the ward. He remained very dizzy and nauseated for the rest of the day and was not able to take even fluids by mouth. The next day he was still dizzy and nauseated, but was able to take fluids by mouth. The hissing tinnitus in the ear that had been operated on persisted. On the second postoperative day he was no more nauseated and also much less dizzy. He also stated that he was able to hear the radio in the room with his right ear (which was still bandaged)—something that had "never happened before." He was discharged on the third postoperative day. During the hospital stay he received tetracycline (Achromycin) 250 mg. q., and this was continued for four more days after the discharge. He was seen on the fifth post-

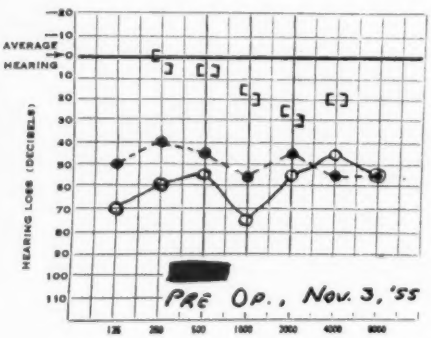

Fig. 1.—Preoperative audiogram.

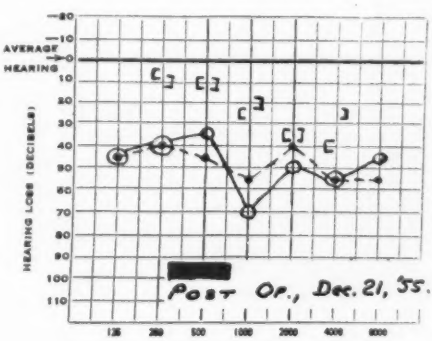

Fig. 2.—Postoperative audiogram.

operative day at the ENT Clinic and he still felt a little unsteady. Some blood clots were removed from the canal and the patient's feeling was that the hearing was better. The tinnitus in the ear that had been operated on was gone entirely. When he was seen again two days later the dizziness was no longer present. On Dec. 21, 1955, two weeks after surgery, the wound in the canal was completely healed; the drum was dry, but dull. An audiogram done on the same day showed only a partial improvement in the treated ear: 20 db. for 250 and 500 d. v., 5 db. for 1000 and 2000 d. v. (Fig. 2).

After this visit the patient unfortunately failed to keep his further clinic appointments, so no more hearing tests were done. On Feb. 26, 1957, he was readmitted to the hospital in a comatose condition for a chronic kidney disease and died in the hospital nine days later, 15 months after mobilization operation, of a chronic glomerulonephritis with uremia and congestive heart failure. During this hospitalization his general condition did not permit any ENT examination. On autopsy, the temporal bones were removed in the routine manner (Lindsay), fixed in 10% formalin, decalcified, embedded in celloidin, cut in horizontal serial sections 24μ thick, and stained with hematoxylin and eosin.

Histological Examination of Temporal Bones

Right Side (Operative Site).

External Auditory Meatus and Drum: The skin incision in the posterior wall of the external auditory meatus is completely healed. The posterior quadrant of the bony sulcus tympanicus is missing, and the surface of the innermost portion of the bony posterior canal wall irregular. In some places, there is apposition of a small amount of pink-staining, newly formed bone. The posterosuperior quadrant of the drum, near the rim, contains a small atrophic scar in which the lamina propria is absent. Toward the handle of the hammer the lamina propria of the posterosuperior quadrant is laid in fine folds, indicating a loss of tension in this part of the drum (Fig. 3).* Near the central margin of the scar a peg of stratified squamous epithelium has grown inward into the underlying stroma towards the edge of the lamina propria. It terminates in a small epidermoid cyst, measuring 0.4 mm. in length and 0.3 mm. in width, which is filled with concentric layers of keratinized material (Fig. 4).

Middle Ear and Mastoid: Middle ear and mastoid are lined with normal, thin mucosa. The mastoid is well pneumatized, the cells slightly irregular in size and arrangement, the mucosa somewhat thickened in many places. Malleus and incus show normal structure, and the incudomalleolar and incudostapedial joints are intact.

More than two-thirds of the circumference of the frame of the oval window is occupied by an otosclerotic focus which surrounds the anterior and most of the superior and inferior quadrant. The focus has an average thickness of 1.5-1.75 mm. and in most places a breccia-like structure, consisting of small pieces of red web-like fibril bone mixed with more or less completely lamellar bone. The marrow spaces are narrow and filled with loose fine fibrillar marrow. The focus extends forward through the inner portion of the fissula ante fenestram and has sent finger-like processes into the adjacent parts of the capsule. There is, however, nowhere evidence of a still progressing destruction of the capsule. In the inner portion of the anteroinferior part of the focus, toward the window niche, the otosclerotic process shows signs of moderate activity (Fig. 5). The marrow spaces are wider, contain fine fibrillar and more cellular

*The photomicrographs were taken in the Photographic Laboratory of the ENT Department by V. Epanchin, M.D.

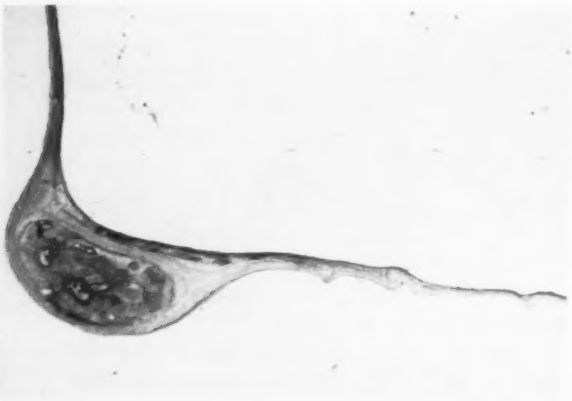

Fig. 3.—Right side. Lamina propria of the posterosuperior quadrant of the drum laid in fine folds.

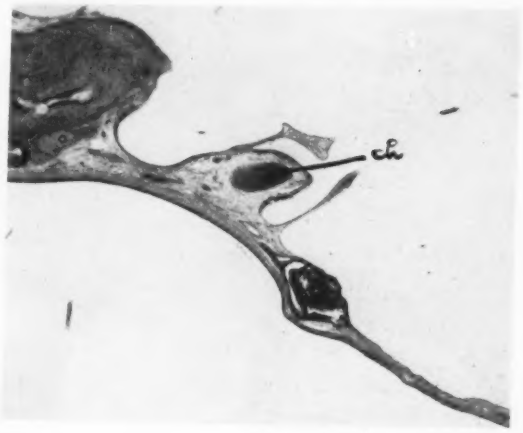

Fig. 4.—Right side. Epidermoid cyst in atrophic scar of the drum. Chorda tympani (*ch*).

marrow, and there is evidence of some internal reconstruction. The innermost part of the focus consists here mainly of blue-staining web-like bone.

In three extensive areas, in the posterosuperior, superior, and anteroinferior parts of the circumference, a thin bar of otosclerotic bone has grown through the annular ligament for a very short distance into the peripheral portion of the footplate (Fig. 5). The ingrowth of otosclerotic bone has come to a standstill everywhere with the exception of the anteroinferior portion, where it is still progressing.

Both stapedial crura consist of skein-like bone only, except in the concavity of the posterior crus, where a thin layer of periosteal bone is noted. The anterior crus had been cut about halfway between capitulum and footplate. The posterior crus shows a transverse fracture near its attachment to the footplate (Fig. 6). The two fragments are connected with dense tissue; no dislocation and no bone formation are noted. The lower part of the anterior crus is embedded into a mass of fairly dense and moderately cellular connective tissue which extends from the promontory into the window niche (Fig. 7). The footplate consists mainly of skein-like bone; a cartilaginous layer is present only in the immediate vicinity of the rim; here the bone contains also some small areas of lamellar bone. In the anterosuperior portion of the footplate the bone is missing in an area measuring about 1 mm. in length and 0.6 mm. in width (Fig. 7); it is replaced by a layer of connective tissue which overlies the slightly thickened endosteum. The missing portion of the footplate has been broken and rotated inward into the vestibule; its peripheral end is still connected at the posterosuperior circumference of the defect with the remainder of the footplate by connective tissue.

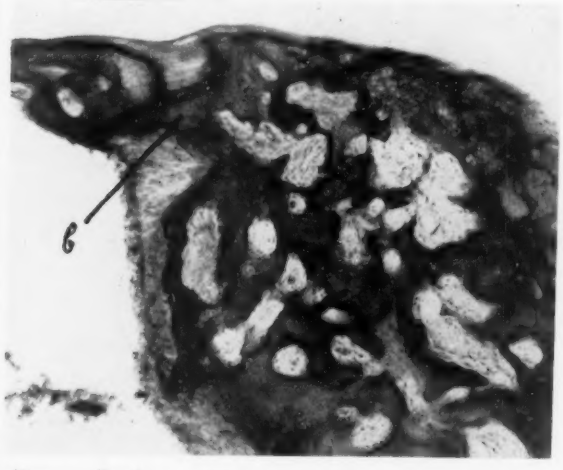

Fig. 5.—Right side. Moderately active otosclerotic focus with thin bar of bone (*b*) extending into the stapedial footplate.

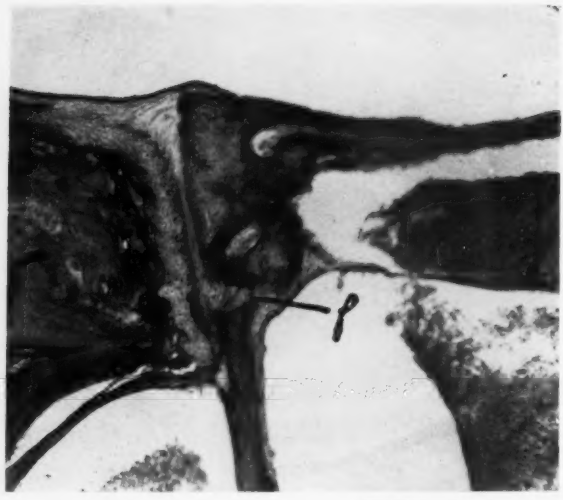

Fig. 6.—Right side. Transverse fracture (*f*) through the posterior stapedial crus.

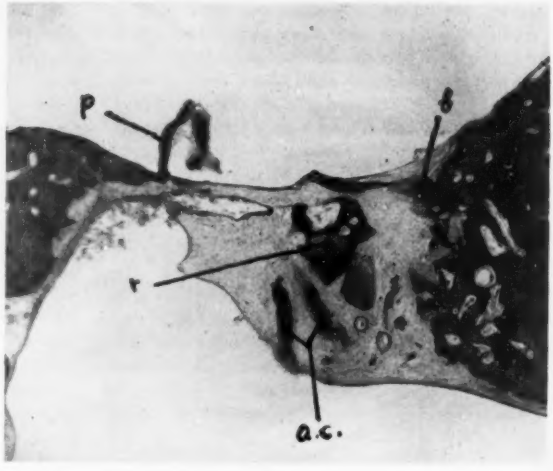

Fig. 7.—Right side. Part of the footplate broken and pushed inward (*p*). Narrow bridge of bone (*b*) extending from the otosclerotic focus into the footplate. Fragments of the anterior crus (*a. c.*). Part of the rim broken away from the footplate (*r*).

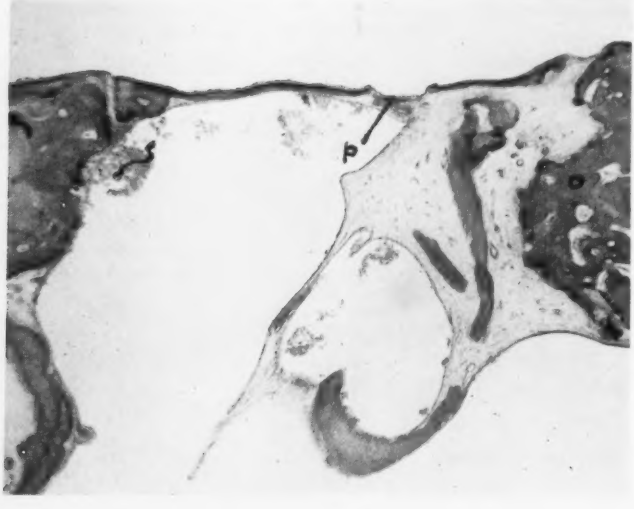

Fig. 8.—Right side. Broken part of the footplate (*p*) slightly dislocated outward. Lower portion of the anterior stapedial crus with part of the bony rim (*r*). Otosclerotic focus (*o*) without stapedial ankylosis.

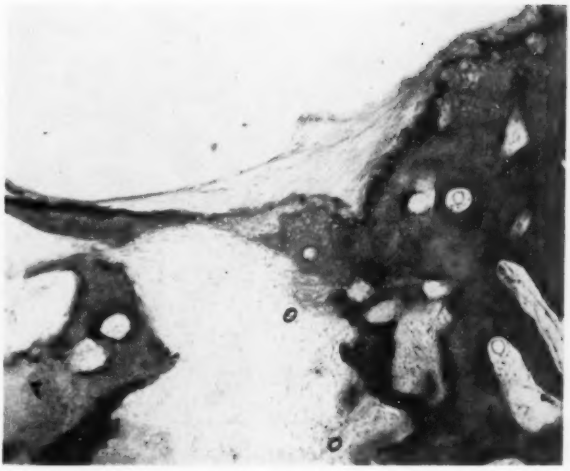

Fig. 9.—Right side. Higher magnification of part of Figure 5. Narrow bridge of bone extending from the otosclerotic focus into the footplate. Part of rim (*r*) broken away from the footplate. Small areas of ossification within the adjacent connective tissue (*o*).

and the continuity of the endosteum has been restored. The part of the footplate which protrudes into the vestibule is covered by a layer of connective tissue. Its tip is also cracked and rotated outward. No reactive changes are seen in the perilymphatic space around the pieces of bone. The anterior part of the footplate itself shows several fractures, and some of the fragments are dislocated slightly outward. The endosteum is slightly thickened, but nowhere there is evidence of bony callus formation (Fig. 8). The lower half of the crus is broken into three pieces, two fragments representing the upper portion of the crus and a bigger one representing the lowermost portion of the crus together with a part of the rim which had been broken off from the footplate in the course of the operation. In some places apposition of a small amount of bone is seen around the fragments; otherwise there are hardly any reactive changes. Part of the cartilaginous cover of the rim of the footplate, together with a small portion of the footplate itself, has remained in place and shows in some places apposition of new bone. In the uppermost portion a narrow bridge of otosclerotic bone extends into the margin of the footplate (Fig. 9); the greater part of this portion of the footplate is, however, not ankylosed. There is nowhere definite evidence suggesting that any part of an already existing bony ankylosis had been broken in the course of the attempts at operative mobilization of the footplate. The surface of the otosclerotic focus in the greater part of this area shows hardly any signs of activity, with the exception of the apposition

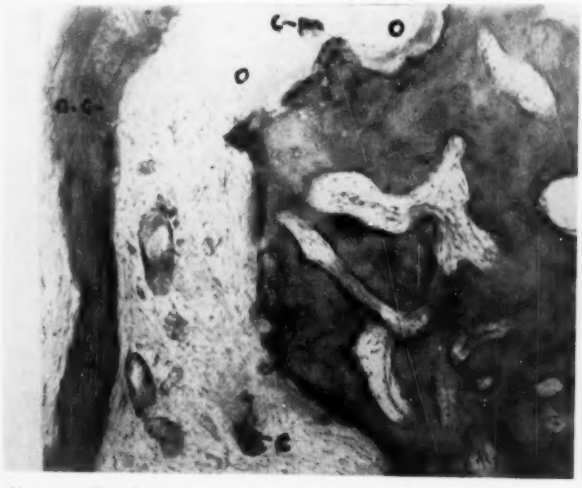

Fig. 10.—Right side. Deposits of osteoid (*o*) at the surface of the otosclerotic focus. Small areas of calcification (*c*) in the adjacent connective tissue. Fragment of anterior stapedial crus (*a. c.*).

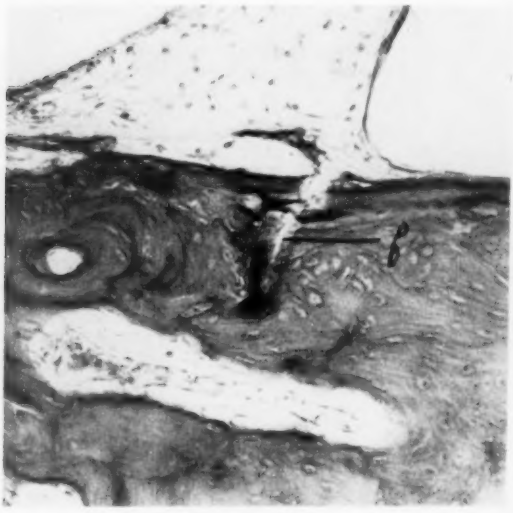

Fig. 11.—Right side. Microfissure (*f*) extending into the otosclerotic focus.

of thin layers of osteoid in several places (Fig. 10). In circumscribed areas signs of a somewhat greater activity can be seen with formation of a network of web-like bone extending into the adjacent connective tissue; the latter also shows small areas of calcification. The labyrinthine capsule contains, in addition to the quite common fissure between the round window niche and the base of the crista ampullaris of the posterior semicircular canal, two additional fissures which are filled with moderately cellular connective tissue. One is located in the lateral labyrinthine wall above the oval window between the facial canal and the macula cribrosa utriculi and extends for a short distance into the uppermost portion of the otosclerotic focus (Fig. 11). The second fissure lies in the medial wall of the vestibule, between the fundus of the internal auditory meatus and the region of the macula sacculi and traverses the canal for the saccular nerve (Fig. 12).

Inner Ear: The membranous parts show moderately severe postmortem changes but no other recognizable pathology. The spiral ganglion shows normal structure, commensurate with the age of the patient.

Left Side (Nonoperative Site)

External Auditory Meatus and Drum: These are without any pathological changes.

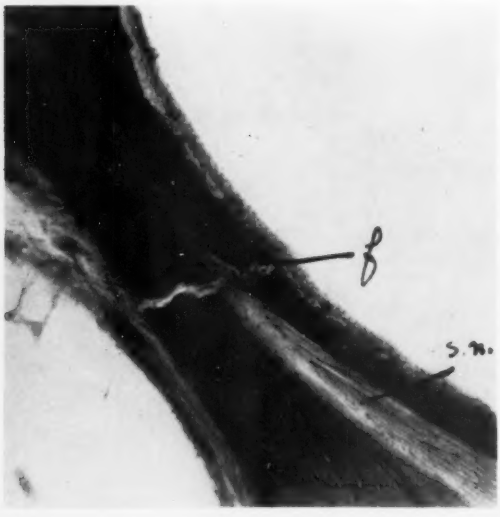

Fig. 12.—Right side. Microfissure (*f*) between fundus of internal auditory meatus and macula sacculi. Saccular nerve (*s. n.*).

Fig. 13.—Left side. Otosclerotic focus with osteoclastic widening of the vascular spaces. Osteoclast (*o*). Bridge of bone (*b*) extending into the footplate.

Middle Ear and Mastoid: The lumen contains a small amount of seropurulent exudate; accumulations of larger masses of polymorphonuclear leukocytes are noted in the window niches and other recesses. The lining mucosa is slightly thickened and shows the signs of a beginning purulent infection. Both window niches, attic, antrum, and some of the periantral cells contain strands and in some places larger masses of organized tissue. The pneumatization of the mastoid is slightly irregular and the lining mucosa in many places somewhat thickened. Malleus and incus, as well as the capitulum of the stapes, show normal structure. The stapedial crura consist exclusively of skein-like bone without any layer of periosteal bone. The footplate consists of an inner layer of cartilage and an outer layer of skein-like bone.

The anterior half of the frame of the oval window is occupied by an otosclerotic focus which in addition extends inferiorly backward approximately to the level of the attachment of the posterior crus to the footplate. The focus measures about 2 mm. in thickness and surrounds almost two-thirds of the circumference of the footplate. Anteriorly small bridges of bone extend in several places through the annular ligament for a very short distance into the footplate and have produced a bony ankylosis of the latter (Fig. 13). In one place the posterior portion of the footplate is slightly displaced inward into the vestibule. The structure of the focus varies. The superior part consists mostly of a breccia with small areas of incompletely lamellar and of red web-like bone with relatively narrow vascular channels and little evidence of activity. Further downward, in the anterior portion of the otosclerotic focus, the more mature bone is confined to the vicinity of the footplate, but even here osteoclastic widening of the vascular spaces is frequently noted (Fig. 13). The small bony bridges extending into the footplate, however, consist of completely quiescent bone. There is nowhere evidence of further invasion of the footplate. The greater portion of this part of the focus consists of less mature web-like bone which sends finger-like processes forward into the adjacent parts of the labyrinthine capsule. In a few places progressive osteoclastic destruction of the capsule from vascular spaces is noted. In the anteroinferior portion of the focus, the marrow spaces are very wide and contain loose, fine fibrillar tissue with wide, thin-walled blood vessels; there is also evidence of moderately active internal reconstruction with osteoclastic destruction of the old bone and deposition of new bone. In the inferior part of the focus the marrow spaces again become smaller and less active. The focus extends forward to the fissula ante fenestram, but there is no connection between the two structures.

The labyrinthine capsule again contains a fissure between the round window niche and the crista ampullaris of the posterior vertical canal but no other fissures.

Inner Ear: There are moderately severe postmortem changes, but no other pathology is noted. The spiral ganglion has a normal appearance, commensurate with the age of the patient.

Summary of Pathological Findings

Right Side.—Atrophic scar in the posterosuperior quadrant of the drum with loss of tension and with formation of an epidermoid cyst within the scar tissue.

Mostly inactive otosclerotic focus in the anterior and most of the superior and inferior portion of the oval window; moderate activity in the vicinity of the window niche. Ingrowth of a thin processus of the focus into the margin of the footplate in three places with evidence of progression in the anteroinferior area only.

Discontinuity in the middle portion of the anterior stapedial crus with shattering of the lower part into three pieces embedded into connective tissue extending from the promontory into the window niche. Unhealed fracture through the posterior crus near its attachment to the footplate.

Operative defect of part of the anterosuperior portion of the bony footplate with displacement of the broken part toward the lumen of the vestibule. Restoration of the continuity of the endosteal lining with slight thickening; absence of reactive changes within the vestibule. Multiple fractures of the anterior portion of the footplate, including the rim, with apposition of small amounts of bone to some of them but without osseous reunion.

No evidence of operative change in any part of the otosclerotic focus or the ankylosing bridges.

Apposition of small amounts of osteoid to the surface of the focus in several places within the operative area; progressive ingrowth into the covering connective tissue in circumscribed places. Three intravital microfissures within the labyrinthine capsule.

Left Side.—Otosclerotic focus of approximately the same extent as on the other side with several thin processes extending into the margin of the footplate without any evidence of progression. Low activity in the superior and inferior part of the focus, moderate activity in the middle portion with progression into the labyrinthine capsule.

One microfissure in the labyrinthine capsule.

Comment

The operation had in this case failed to mobilize the ankylosed footplate as such; the three processes of otosclerotic bone which extended from the focus into the margin of the footplate had remained intact. During the forward eversion of the lower stump of the anterior crus, the anterosuperior portion of the footplate was broken into several pieces and the endosteal lining was torn. A portion of the footplate was rotated inward into the vestibule. At this moment, the patient experienced a sudden improvement in hearing and vertigo.

Instead of a stapes mobilization a "footplate fenestration" (or better "footplate fracture" or "footplate puncture") had been performed in this case.

The tear in the endosteum healed completely, and the defect in the footplate was filled with a layer of connective tissue. There is very little reaction and definitely no bony callus formation around the broken pieces of the footplate, and callus formation is also absent in the fractures through both stapedial crura. The latter also consist of skein-like bone.

The absence of labyrinthine reactive changes, particularly the absence of connective tissue proliferation around the bone chip sticking into the lumen of the vestibule is noteworthy. It is in all probability the result of the prevention of a postoperative infection by the tetracycline.

Neither the operative procedures nor the postoperative reactive changes in the oval window niche seemed to have stimulated to any noticeable degree the growth of the otosclerotic focus.

The only postoperative audiogram, taken two weeks after the operation, showed only an insignificant hearing gain in the lower range, but this does, of course, not permit any conclusions as to the ultimate hearing result.

It becomes apparent from the study of the serial sections through the footplate that, since indirect mobilization from the neck or head of the stapes or the long process of the incus had been impossible, the best results would have been achieved either by breaking the bridges of otosclerotic bone extending into the footplate, with complete preservation of the ossicular chain, or by anterior crurotomy and breaking the posterior, mobile part of the footplate away from the immobilized part.

Because one of the processes extending into the footplate still showed signs of activity, the possibility of reankylosis in this area existed, although it is impossible to tell if and when this would have occurred. Anterior crurotomy with posterior foot-

plate fracture should have better chances, but the frequency of fractures of the posterior crus, as also evidenced in this case, is a serious drawback to this method. At the present time we feel that it is preferable to produce a transverse fracture through the uninvolved portion of the footplate in the vicinity of the focus but to leave at first both crura intact. For the majority of the cases the elasticity of the nonankylosed crus, be it anterior or posterior, is sufficient to permit the transmission of movements from the ossicular chain to the broken, mobile part of the footplate. This manifests itself on the operating table in a satisfactory hearing improvement, which still increases after the drum has been put back into position. If no hearing improvement occurs or if it disappears after repositioning of the drum, one must assume that the crura are too thick or their elasticity insufficient. Then the ankylosed crus can be broken by gradually and cautiously cutting through it with a saber needle or another suitable instrument.

On the left side, where the ankylosing bony bridges were completely inactive, direct mobilization of the footplate would have had a good chance for success.

The bony bridges in this case might even have permitted indirect mobilization if somewhat greater force had been applied.

Judging from the frequency with which mobilization is possible on the operating table by patiently breaking through ossified portions of the annular ligament, one comes to the conclusion that this type of otosclerotic footplate ankylosis is not uncommon. This assumption is confirmed by the findings of Rüedi and Spoendlin.

The main objection to mobilization through the otosclerotic focus is derived from the fact that an active focus would soon reankylose and that even a completely inactive focus might at any moment become active again. The great number of footplate mobilizations which so far have remained successful over a considerable period of time seems to indicate that the danger of callus formation in fractures through small inactive otosclerotic foci had perhaps been somewhat overemphasized. In some of them the possibility still must be considered that a normal, noninvolved part of the footplate had been broken by the operator without his realizing it. The recognition of very active and active foci during the operation is not too difficult with appropriate magnification of the field, because of their pinkish or reddish color. Much more difficult or even impossible, however, is the recognition of only moderately active foci. The practical conclusion to be drawn from these facts seems to be that breaking through ossified portions of the annular ligament should be attempted only if the ankylosing bony bridge appears thin and inactive. In all other cases footplate fracture seems the more logical procedure. The final answer to this question will not be found before the results of the follow-up studies over a prolonged period of time of a great number of cases treated by one of the two methods can be compared with each other.

The scar in the posterosuperior quadrant of the drum represents most probably a healed operative tear; the formation of the epidermoid cyst in the scar tissue is an interesting accidental finding. It makes one wonder if such findings will not become more frequent with the great number of myringoplasties now performed.

The loss of tension in the posterosuperior quadrant of the drum deserves attention. It remains to be seen if it really has an effect on the hearing as assumed by some authors.

It is not our intention to revive the old controversy about the nature and significance of the microfissures in the labyrinthine capsule (O. Mayer). There can be no doubt about the intravital nature of the fissures observed in our case. Of particular interest is the fissure in the lateral wall of the right labyrinth above the oval window, which extends for a short distance into the uppermost portion of the otosclerotic focus.

According to O. Mayer, otosclerotic foci can be regarded as reactive changes to mechanical stresses acting on certain areas of the labyrinthine capsule. They seem to represent an attempt of nature to reduce these stresses which if unrelieved lead to microfissures in certain typical areas. If one accepts O. Mayer's theory, the extension of the fissure into the otosclerotic focus would indicate that the focus had only insufficiently reduced the mechanical stress and that the microfissure had occurred long after the otosclerotic focus had started to develop. No similar case has to our knowledge so far been reported. Fowler recently described an incidental fracture through the footplate in the course of a fenestration operation three weeks before death, without reactive changes around the fragments.

Summary

A detailed description is given of a bilateral otosclerotic focus with a stapes ankylosis in a man, 58 years of age, on whom a stapes-mobilization operation on the right side had been performed 15 months before death.

The histological examination showed that a "footplate fenestration" rather than an actual mobilization has been done.

The footplate ankylosis had been caused on both sides by several short and thin, and, in all probability, easily breakable bridges of otosclerotic bone extending through the annular ligament. Only one of the bridges showed signs of activity; all the others consisted of completely inactive bone.

The relative merits of direct footplate mobilization and of anterior crurotomy with footplate fracture in the operative treatment of such cases are discussed.

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Surgical Landmarks in Rhinoplasty

JOHN A. CINELLI, M.D., New York

In practically all rhinoplasties it is necessary to reconstruct the tip of the nose so that it will appear well proportioned and natural. In attempting to establish an ideal procedure for such a difficult problem, it was necessary to consider the advantages and disadvantages of a great number of prevalent methods as described, observed, discussed, and practiced.

Over many years of constant application and modification of various phases of existing acceptable methods, certain significant observations were made. In the first place, when the usual intercartilaginous and transfixion incisions were made, there developed certain anatomical landmarks which were most helpful and practical guides in producing a pleasing and natural tip. These landmarks are distinctive "red areas" and inverted "V" slits and are always present after the intercartilaginous and transfixion incisions are made. They are also found in secondary cases. For the sake of simplicity it seems logical to designate these landmarks according to their actual appearances. These red lines are simply the unlined upper borders of the lateral crura (lower laterals). It is only when they are completely excised, in those cases in which this operative procedure is indicated, that we obtain a natural-looking tip. They appear red because they are not covered with mucous membrane when exposed and consequently are in a raw or denuded state. The mucous membrane

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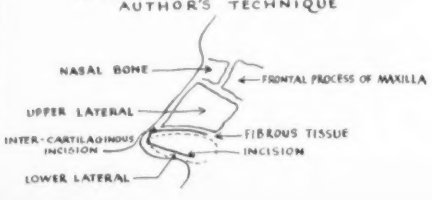
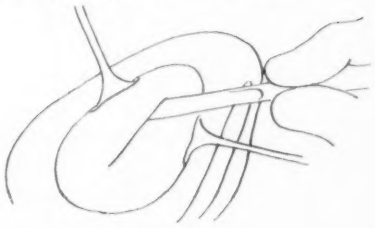
SIMPLE RHINOPLASTY
AUTHOR'S TECHNIQUE



INTERCARTILAGINOUS INCISION

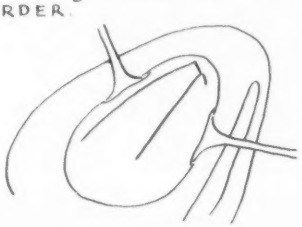


or vestibular skin has a tendency to show the underlying crural structures as pearly gray.

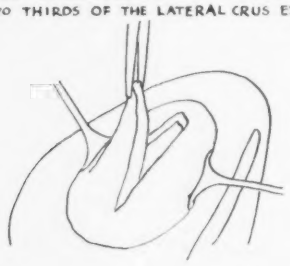
To obtain a natural-looking tip and avoid a pinched effect, the procedure described below is used in about 95% of all tip operations. Even when the tip is perfectly normal before the operation is performed, it usually becomes necessary to make some adjustments so that it may naturally fit in with the rest of the nose.

A parallel incision is made about ⅛ in. above the inferior border of the lateral crus through the vestibular skin and cartilage, extending from about ¼ in. from its lateral end up to the angles, taking care that the ⅛ in. distance from the rim is maintained throughout. In order to find the inverted V, it is necessary to evert the angle of the tip and note a slit at the top of the angle. This slit looks like an inverted V and corresponds to the superior border of the angle. It must not be confused with another slit or V which is lateral to the one described, and the main

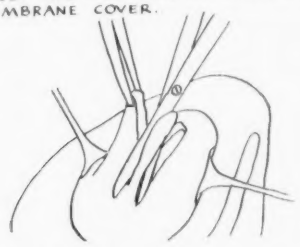
INCISION THROUGH LATERAL CRUS ABOUT ⅛" FROM ITS INFERIOR BORDER.



FULL THICKNESS FLAP OF THE UPPER TWO THIRDS OF THE LATERAL CRUS EXPOSED.



EXCISION OF RED AREAS FROM THE MEDIAL BORDER OF THE LATERAL CRUS. THIS AREA HAS NO MUCOUS MEMBRANE COVER.



one can be easily recognized by its dovetailing perfectly with the superoanterior border of the septum when the tip is temporarily placed back into its original position. Another positive method that may be employed to identify the proper slit is to grasp the anterior end of the upper lateral cartilage, whether it be freed or attached, and allow it to fall back into its original position. You will find that it fits perfectly into a slit—it literally points to the slit. This slit is the anatomical inverted V, and guides the surgeon to the exact position of the angle. It is surgically created when the intercartilaginous and transfixion incisions are made.

By everting the lateral crus close to its angle, the inverted V is exposed. A perpendicular incision is made at the apex of the V and continued slightly medialward and upward for about one-half the length of the angle, leaving the anterior half of the angle intact. This incision joins the parallel incision of the rim almost at right angles, forming an "L"-shaped outline. The flap thus outlined is dissected from the skin so that the lateral crus with its vestibular lining is freed for about two-thirds of its length.

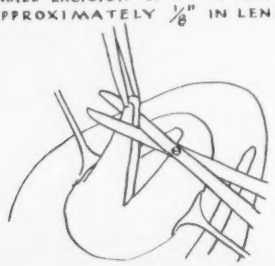
In exposing the flap there is present a distinct red line along its superior border. The very tip of the flap is part of the upper half of the medial crus and usually curls. In excising the red lines it is observed that the thickness of the lateral walls of the tip is reduced. Moreover, when the cartilaginous curled tips of the flaps are cut away submucosally and the flaps are allowed to fall back into their original positions, a slight retroussé effect is produced.

The explanation for this fact is twofold. First, the anterior halves of the angles of the tip are left intact, thereby maintaining their natural projections. Second, since the upper halves of the angles are deprived of their projections by the elimination of the curled tips, they fall into place just below and behind the projected intact anterior angles, thereby creating a retroussé tip.

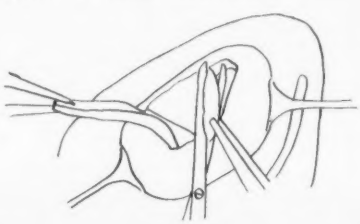
However, if the angles of the tip are still too wide, it is advisable to cut through the anterior intact angles submucosally without removing any cartilage, and only in extremely wide angles of the tip is a small segment of the cartilage removed submucosally and slightly lateral to the angle.

1149 Park Ave. (28).

SMALL EXCISION OF TIP OF FLAP OF APPROXIMATELY 1/8" IN LENGTH.



TRIMMING OF MEDIAL BORDER OF THE UPPER LATERAL CARTILAGE.



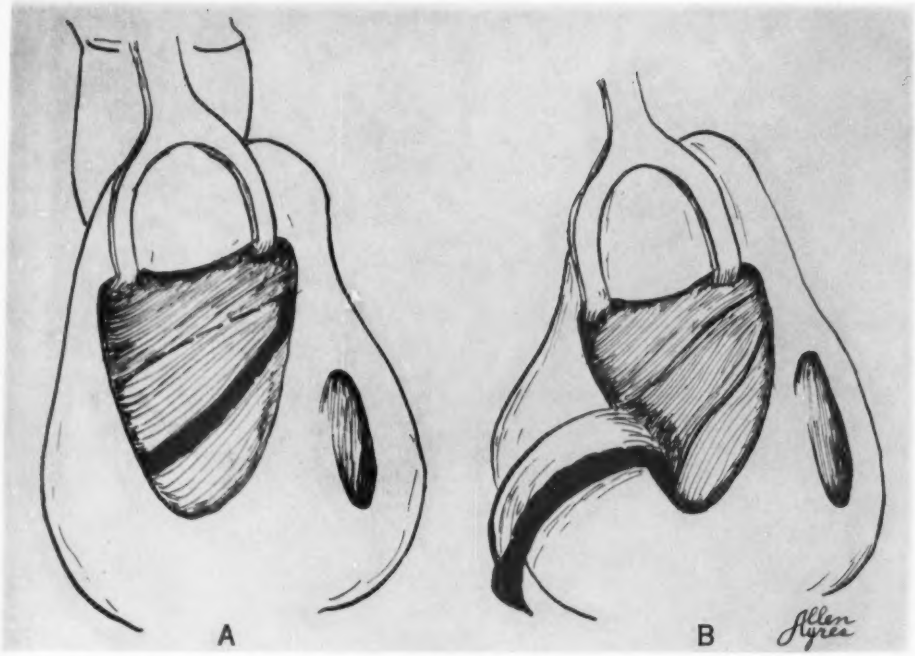


Fig. 1.—*A*, interior of nose, alar rim everted. Incisions outlining flap indicated. Location of red area noted. *B*, flap freed. Upper border is red (without mucous membrane lining). Curled end of flap (in green) is part of upper half of medial crus.

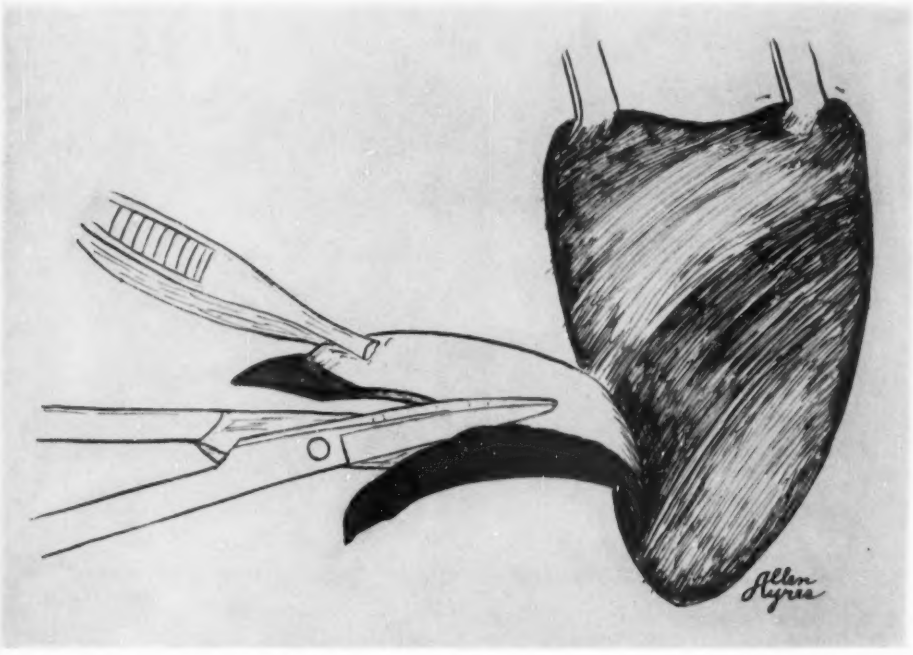


Fig. 2.—Red area being excised from the lateral crural flap. The cartilaginous curled green area is excised submucosally, but this is not indicated.

Fig. 3 (Case 1).—*A*, before operation: front view showing bulbous tip. *B*, before operation: profile view showing prominent nasal hump. *C*, after operation: showing natural symmetrical nostrils and pleasing tip (not pinched). *D*, after operation: profile view showing retroussé tip.

Fig. 4 (Case 2).—*A*, before operation: front view showing slightly long nose and invisible nostrils. *B*, before operation: profile view showing moderate hump. *C*, after operation: front view showing symmetrical nostrils and natural unpinched tip. Nostrils are moderately visible. *D*, after operation: profile view showing a moderate retroussé tip and shorter nose.

Fig. 5 (Case 3).—*A*, before operation: front view showing invisible nostrils. *B*, before operation: profile view showing large nasal hump and long nose. *C*, after operation: nostrils visible and tip natural in appearance. *D*, after operation: smooth, straight profile with slightly retroussé tip.

Fig. 6 (Case 4).—*A*, before operation: front view showing thin tip and symmetrical nostrils. *B*, before operation: profile view showing moderate dorsal "hump" and long nose. *C*, after operation: symmetrical nostrils and natural unpinched tip. *D*, after operation: straight profile; shorter nose.

Fig. 7 (Case 5).—*A*, before operation: front view. *B*, before operation: profile view showing moderate dorsal hump. *C*, after operation: front view showing symmetrical nostrils and unpinched tip. *D*, after operation: profile view showing straight dorsal profile and slightly retroussé tip.

Abscess Tonsillectomy

Seven Hundred Twenty-Five Cases

BERTEL GRAHNE, M.D., Helsinki, Finland

The first abscess tonsillectomy was performed nearly 100 years ago (1859) by Chassaignac. He also described the course of development of peritonsillar abscess. His operation, however, fell into disuse. It was not until 30 years later that interest in the treatment of peritonsillar abscess was stimulated by Chiari, who suggested a simple incision for opening "ripe" abscesses. Winckler (1911) was the first to suggest the use of tonsillectomy as a routine method, and the appellation "Father of abscess tonsillectomy" has been given to him. The advantages and disadvantages of the two methods have since been the subject of much discussion. Methods differing to some extent from these two have been reported. Thus, Levinger suggested so-called partial tonsillectomy: he removed the upper pole of the tonsil and left the lower pole intact. In Finland, Meurman previously used Levinger's method. Loch performed abscess tonsillectomy in two stages. He made a fairly wide incision over the abscess and luxated the tonsil medially, enucleating it a few days later when the virulence of the bacteria had subsided.

As early as the beginning of this century, Sommer and Winckler reported encouraging results of abscess tonsillectomy. Some later authors have advocated abscess tonsillectomy as the method of choice in the treatment of peritonsillar abscess (Linck, Söderberg, Zambrini, Eckert-Möbius, Virtanen, Bateman and Kodicek).

Submitted for publication Jan. 25, 1958.

From the Otolaryngological University Hospital (Head: Professor Y. Meurman, M.D.)

At the Otolaryngological University Hospital in Helsinki, tonsillectomy has been performed in cases of peritonsillar abscess since 1933. Virtanen's doctorate thesis consisted of a presentation of 379 cases operated on in the period 1933 to 1947. The present series is from 1948 to 1956 and comprises 725 cases, all treated on the same principles since the advent of antibiotics. Bilateral tonsillectomy was used as the routine method for peritonsillitis. Unilateral tonsillectomy was used only exceptionally. Preoperative incision of the abscess was not done. All cases, both severe and mild, in which peritonsillitis is mentioned in the records, are included. Seventy-three children were operated on under light ether anesthesia or V. A. M. (divinyl ether and ethyl ether), and three patients with intubation anesthesia. We use Gowen's conduction anesthesia as modified by Meurman, induced as follows:

A 1% procaine solution is used. An injection of 3 cc. into the palatine foramen or the neighborhood of it makes the upper pole of the tonsil insensitive. For anesthesia of the lower pole the injection begins somewhat laterally of the lower insertion of the anterior faucial pillar. During the passage of the needle through the tissues to the level of the posterior pillar, procaine solution is being continuously injected. With this method good anesthesia is obtained without bringing the needle into contact with the abscess. An ordinary bilateral tonsillectomy is then performed. The tonsil on the healthy side is first enucleated and then the affected side operated upon. The pus, when pouring out, is removed by suction.

The great majority of the patients were given a course of penicillin. Some other antibiotic was used only if the patient did not tolerate penicillin. When the clinical picture was exceptionally mild, antibiotics were not always given. After operation

TABLE 1.—*Distribution of Cases over the Different Years*

Year	Men	Women	Total
1948	10	6	16
1949	17	13	30
1950	18	5	23
1951	31	27	58
1952	40	40	80
1953	40	47	87
1954	48	47	95
1955	68	79	147
1956	93	96	189
	365	360	725

TABLE 2.—*Distribution of the Patients by Age and Sex*

Age, Years	Men	Women	Total
<10	23= 6.1%	26= 7.3%	49= 6.8%
10–20	103=28.4%	115=31.9%	218=30.1%
20–30	127=35.0%	104=28.9%	231=31.9%
30–40	61=16.7%	62=17.3%	123=16.9%
40–50	38=10.4%	29= 8.0%	67= 9.2%
50–60	11= 3.0%	16= 4.4%	27= 3.7%
>60	2= 0.4%	8= 2.2%	10= 1.4%
	365=100%	360=100%	725=100%

the patients have immediately felt immensely relieved. According to our experience after enucleation of the tonsils the postoperative pain is mostly less on the side of the abscess. This is due to the fact

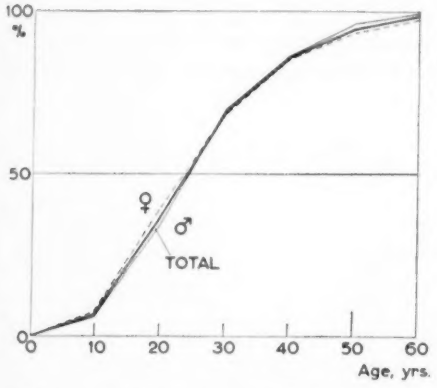


Fig. 1.—Cumulative percentile distribution curves showing the distribution of the patients by age and sex. (At each point, the height of the curve expresses the percentage of patients who were younger than the age indicated at that point.)

that an abscess membrane covers the bed of the tonsil, whereas on the other side a raw surface remains for a time before a membrane of fibrin will be formed. The greatest relief for the patient during the immediate postoperative period is that there will be no retention of pus; thus no recurrence of pain will occur.

Table 1 shows an annual increase in the number of operations performed at this Hospital. This increase does not necessarily imply increased morbidity; it probably only signifies that abscess tonsillectomy has become more widely known and appreciated by the doctors who refer their patients to the Otolaryngological University Hospital. Male and female patients have been admitted in roughly equal numbers.

It is seen in Table 2 that 79% of cases fall within the age groups 10 to 40 years. The age groups 10 to 30 years include 62%. Thus, peritonsillitis is a disease mostly sustained in the prime of life. The cumulative percentile distribution curve (Fig. 1) shows the same age distribution for men and women, and a probable age of about 24 years.

It is seen in Table 3 that peritonsillitis is not infrequent in children, 17% of the patients being 1 to 14 years old. After the age of 7 years this disease is relatively common. The youngest patient with peritonsillar abscess was 8 months old. In children, it has been the rule at this Hospital to perform tonsillectomy on the affected side only, except in cases with a previous history of recurrent tonsillitis. The same practice was adopted with regard to elderly patients.

The distribution of peritonsillitis over the different months of the year corresponds roughly to the incidence of acute tonsillitis. Table 4 shows the smallest number of admittances for the period January to March.

The fact that as many as 79% of the patients had a history of one or more

TABLE 3.—*Peritonsillitis in Children at Different Ages*

Age, Yr.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	Total
No. Cases	1	2	3	5	2	2	11	16	15	8	22	11	13	15	126=17.4%

TABLE 4.—*Distribution of Cases Over the Different Months*

Month	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Total
No. Cases	39	44	30	58	65	68	79	69	67	63	78	65	725

previous episodes of tonsillitis or peritonsillitis constitutes an indication for bilateral surgical intervention as a routine method in the treatment of peritonsillar abscess.

In 75% of cases symptoms had been present for two to seven days (Table 6) before admission. As a rule, abscess tonsillectomy was performed as soon as was technically possible after admission, and a first injection of penicillin was given immediately before operation. It appears in Table 6 that 27% of the patients had had symptoms for seven days. This high percentage calls for an explanation. The calculation is based on the journal reports, which frequently contain the statement that symptoms had been present for a week. Obviously, however, the expression a week should not always be interpreted as meaning exactly seven days. The cumulative percentile distribution curve (Fig. 2) shows the probable duration of symptoms to be six days.

TABLE 5.—*Earlier Tonsillar Inflammations*

Earlier abscesses and tonsillitis	184=28.6%
Earlier tonsillitis	323=50.2%
No earlier tonsillar inflammations	136=21.2%
Total	643=100%

TABLE 6.—*Duration of Symptoms Before Abscess Tonsillectomy*

Duration of Symptoms	No. of Cases
1 day	7= 0.5%
2 days	66= 9.2%
3 days	82=11.4%
4 days	100=13.8%
5 days	73=10.0%
6 days	24= 3.4%
7 days	194=26.8%
1–2 wk	135=18.7%
2–3 wk	18= 2.5%
3–4 wk	18= 2.5%
4– wk	8= 1.2%
Total	725=100%

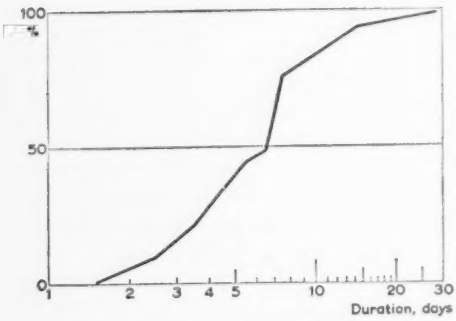


Fig. 2.—Cumulative percentile distribution curve showing the duration of symptoms. (At each point, the height of the curve expresses the percentage of patients who were ill for a shorter period than the number of days indicated at that point.)

TABLE 7.—*Type of Inflammation*

Peritonsillitis with pus formation	650=89.6%
Peritonsillitis without pus formation	75=10.4%
Total	725=100%

TABLE 8.—*The Affected Side*

	No. of Cases
Right	336=46.4%
Left	340=46.9%
Bilateral	49= 6.7%
Total	725=100%

Accumulation of pus was observed in 90% of cases (Table 7). In the remaining 10%, phlegmon, necrosis, or infiltration of the peritonsillar tissue were present. Occasionally an empty abscess cavity was found.

Bilateral peritonsillitis was present in 7% of cases (Table 8). The presence of bilateral affection sometimes constituted an unexpected finding at operation. Thus, even if the affection appears to be unilateral, it may, in fact, sometimes be bilateral. These masked cases were diagnosed and adequately treated, thanks to the fact that

TABLE 9.—*Temperature Immediately Before Abscess Tonsillectomy*

Temperature (C)	No. of Cases
≤37.0	142=19.6%
37.1–37.5	203=28.0%
37.6–38.0	193=26.6%
38.1–39.0	157=21.7%
>39.0	30= 4.1%
Total	725=100%

TABLE 10.—*Duration of Fever After Abscess Tonsillectomy*

Duration of Fever	No. of Cases
No fever during hospitalization	47= 6.6%
Fever disappeared on	
1st day after operation	210=28.9%
2nd day after operation	301=41.6%
3rd day after operation	126=17.5%
4th day after operation	21= 2.9%
5th day after operation	15= 2.0%
6th day after operation	2= 0.2%
7th day after operation	1= 0.1%
Fever for more than 7 days	2= 0.2%
Total	725=100%

bilateral tonsillectomy is used as a routine method at this Hospital.

Peritonsillitis is practically always accompanied by fever. Although in 20% of the present cases (Table 9) the temperature was within normal limits immediately before operation, the course had not been entirely without fever. The histories record elevation of temperature before admission to hospital. In 55% of cases a temperature of between 37 and 38 C (98.6 and 100.4 F) was measured preoperatively in the axilla. Temperature exceeding 39 C (102.2 F) rarely occurred.

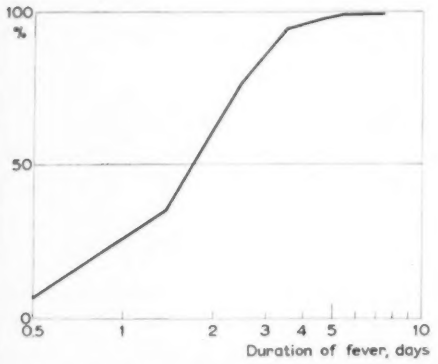


Fig. 3.—Cumulative percentile distribution curve showing the duration of fever. (At each point, the height of the curve expresses the percentage of patients who had fever for a shorter period than the number of days indicated at that point.)

Ninety-five per cent of the patients had a normal temperature by at least the third day after operation (Table 10) and could be discharged. Seven per cent had no fever during the whole period of hospitalization. In only 0.2% of cases did fever persist for more than seven days. The cumulative percentile distribution curve in Figure 3 shows the probable duration of fever to be slightly less than two days after operation.

TABLE 11.—*Days in Hospital*

Days	No. of Cases
1	4= 0.5%
2	55= 7.8%
3	220=30.3%
4	264=36.4%
5	109=15.0%
6	39= 5.3%
7	15= 2.1%
8-14	19= 2.6%
Total	725= 100%

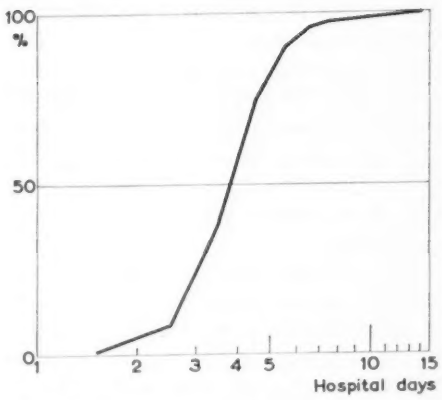


Fig. 4.—Cumulative percentile distribution curve showing the duration of hospitalization. (At each point, the height of the curve expresses the percentage of patients who were hospitalized for a shorter period than the number of days indicated at that point.)

TABLE 12.—*ESR Immediately Before Abscess Tonsillectomy*

ESR/1 Hr.	No. of Cases
<25	117=16.7%
25-50	315=44.9%
51-75	197=28.1%
76-100	57= 8.1%
>100	15= 2.2%
Total	701=100%

TABLE 13.—*Leukocyte Count Immediately Before Abscess Tonsillectomy*

No. in Cu. Mm. Blood	No. of Cases
< 8,000	108=22.1%
8,000-15,000	266=54.4%
15,000-20,000	89=18.2%
20,000-25,000	18= 3.7%
>25,000	8= 1.6%
Total	489=100%

Only 10% of the patients were hospitalized for more than five days (Table 11). The cumulative percentile distribution curve (Fig. 4) shows that the probable duration of hospitalization was four days.

A moderately increased ESR (25-50) occurred in 45% of cases (Table 12). Only 10% of the patients had an ESR exceeding 75 mm/hr.

If a leukocyte count of 8000 cu. mm. is regarded as the upper normal limit, 22% of the patients (Table 13) had a normal leukocyte count. In the majority of cases the leukocyte count was moderately increased (8000-15,000).

No complications occurred in any of the present 725 cases, either during operation or afterwards. Thanks to the use of conduction anesthesia, any bleeding vessels were immediately detected during operation and ligated.

Summary

This is a report on the cases of abscess tonsillectomy treated at the Otolaryngological University Hospital in Helsinki during the period 1948-1956. The series comprises 725 cases. All cases where peritonsillitis is mentioned in the records are included. At this hospital, bilateral tonsillectomy is used as a routine method in the treatment of peritonsillitis. Unilateral tonsillectomy is performed only on children and elderly patients with no history of recurrent peritonsillitis. Penicillin treatment is instituted immediately before operaton. Other antibiotics are used only if the patient does not tolerate penicillin. Of the present 725 patients, 649 were operated upon under conduction anesthesia induced by Gowen's method as modified by Meurman. Ninety-five per cent of the patients were without fever by at least the third day after operation and could be discharged. The average period of hospitalization was four days. No noteworthy complications occurred either during operation or afterwards.

Otolaryngological University Hospital.

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Basic Hearing Tests and Information They Reveal

WALLACE RUBIN, M.D., New Orleans

We may never hope to understand fully what we say so long as we think we already do.

WENDELL JOHNSON

An understanding of basic hearing tests has become a necessity for the otologist in this day of hearing rehabilitation and reconstructive otologic surgery. Perusal of any recent otolaryngologic journal reveals marked emphasis on audiologic investigation and reflects the otologist's concern as to the type of hearing test that should be used for specific problems of hearing evaluation. In the August, 1957, issue of the A. M. A. ARCHIVES OF OTOLARYNGOLOGY of 12 major articles 7 were titled as follows: "Audiology"; "Masking Levels for Clinical Use"; "Additional Data on Bone-Conduction Shift When the External Auditory Meatuses Are Occluded"; "A New Concept in Auditory Screening"; "Conservative Management of Chronic Otitis Media"; "Histopathology of Stapes Ankylosis," and "Aerotitis Media." A passage from "The Nature of Mathematics" by Philip E. D. Jourdain is applicable to the otologists' dilemma with hearing tests. In the 1800's he wrote, "Just as it is with astronomy, so it is with all other sciences—both those of Nature and Mathematical science: the very essence of them is the prevention of waste of the energies of muscle and memory. There are plenty of things in the unknown parts of science to work our brains at, and we can only do so efficiently if we organise our thinking properly, and, consequently do not waste our energies." In the face of all the investigative work with new concepts, new hearing tests, and modification of older hearing tests, it is of the utmost importance that we establish just what hearing information we desire and just how we should arrive at it.

When a patient consults us regarding a hearing loss we are interested in determining the following: First of all, does the patient have a hearing loss? Second, is the loss in one or both ears? Third, if there is pathology, where is it located, and how much loss is there in terms of quantity? Whether we accomplish this with expensive equipment and complicated hearing tests or with accurate observation and simple procedures will matter little to the patient. If we have determined that the patient's hearing loss is conductive, then we may be able to restore what hearing has been lost by medical or surgical means. If the loss is in the perceptive apparatus, then the patient will have to use what hearing he has left to the best advantage. This can be accomplished by educational and rehabilitative measures, such as lip reading, speech training, and the judicious use of amplified sound.

There is no question that a painstaking history and complete physical examination are of extreme value. Some pertinent questions will help to orient our thinking in terms of whether the loss will be conductive or perceptive. Some clues as to etiology and type of hearing loss can also be obtained from a critical evaluation of the patient's speech and the manner of response during questioning and examination.

Is the problem that confronts the patient one of understanding people or is it that conversation is not loud enough? In children, is the problem one of behavior, inattention, or distractability, or is it that the child seemingly does not hear?

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Is the hearing loss present in both ears, and, if so, is the loss equal? Did the loss begin gradually or has it been sudden in onset?

Is the hearing loss accompanied by other symptoms, such as tinnitus, dizziness, or headache? Was it associated with the high fever of an illness or did it follow some trauma to the head, such as skull fracture?

Has the loss been associated with any ear disease? Did it begin in childhood? Was there any history of ear disease in childhood? Protracted colic? Skin rashes? Hay fever, asthma, frequent colds?

Has there been any history of drug ingestion in large doses? Small doses over a prolonged period of time? Quinine? Streptomycin? Salicylates?

Has there been any history of exposure to excessive noise? Saw mill? Punch press? Boilermaker? Shipyard worker? Aircraft industry? Military background?

What is the general health status of the patient? Cardiac? Arteriosclerotic? Hypertensive? Any other chronic disease?

Is there any history of ear, nose, and throat surgery? Tonsillectomy? Adenoidectomy? Submucous resection or sinus surgery? Ear surgery? Any history of x-ray or radium therapy?

Has the patient ever used a hearing aid? What type? With what results? Does the patient use a hearing aid at the present time?

With the history and physical examination completed, the medical hearing evaluation can be undertaken. Examination with tuning forks should be an integral part of the physical examination. There is much confusion as to what can be accomplished with tuning forks. A current comprehensive text on hearing testing written by a very able audiologist, says, "It seems fair to say, however, that the tuning fork tests are limited and that they are mostly designed to tell the clinician whether his patient has a hearing loss of the conductive type or the more central perceptive, or nerve type." A few paragraphs later in the same text the following appears: "In the hands of a precise, experienced clinician it appears that the tuning fork is a more useful diagnostic instrument than is the more precise pure-tone audiometer in the hands of an inexperienced, careless tester." Obviously, there is confusion not only in the ranks of the otologists but also in the audiologic field. I wholeheartedly concur with the author when he says that tuning fork tests can give us a very adequate working idea of a patient's hearing status to correlate with our physical findings. The otologist who correlates what he has found by questioning with what he sees with the otoscope and what he has determined with the tuning forks and pure-tone audiometric and speech tests, is unquestionably in the driver's seat to make an accurate diagnosis of the patient's hearing defect.

When the otologist has evaluated the patient's hearing with tuning forks as a part of the physical examination, he can properly advise his audiometric technician as to what to expect in testing. He can suggest that masking will be necessary and that lateralization will be a problem. The otologist will have valuable information with which to check the quantitative findings of the pure-tone and speech tests. He can be certain of the accuracy of the hearing tests and the calibration of the electronic instruments when he correlates the tuning fork findings with those of his audiometric technician.

Admittedly, the Weber test is very unreliable, but if it lateralizes, we can make certain assumptions. The lateralization is to the better hearing ear with perceptive losses and to the poorer hearing ear with conductive losses. The patient's hearing by air conduction compared with the air conduction of the tester can give us qualitative information concerning the hearing loss.

The Rinne test determines whether the hearing is normal or whether the loss is conductive or perceptive. A normal hearing person or one with a perceptive hearing loss will hear the pure tone longer by air than by bone conduction. When the situa-

tion is reversed or when hearing is the same by air as by bone, we have a conductive type of loss. A very useful suggestion with the Rinne test, particularly in testing children, is to ask whether the tone is heard better (louder) by air than by bone. Many persons can evaluate the modality of loudness with less difficulty. Testing the Rinne with 250, 500, and 1000 cps forks will furnish further information regarding the configuration of the hearing curve. Lateralization of the bone conduction to the ear not being tested with the Rinne will help the otologist in recommending masking for the pure-tone audiometric test and also caution him in his interpretation of the bone-conduction curve of the ear with the poorer hearing.

The Schwabach test, which is a comparison of the patient's bone conduction with that of the tester, will of course, provide information as to the status of the nerve of hearing at the various frequencies tested. The use of the 64 cps fork for testing air conduction provides valuable information as to the mobility of the stapes.

All of the tests with tuning forks should be performed with pulsating pressure for bone-conduction tests and interrupted responses for air-conduction tests. In this way we can be certain that the patient is responding to an auditory stimulus.

With a presumptive hearing diagnosis in mind we can proceed to the pure-tone audiometric and speech testing. Of course, a methodical, precise approach to pure-tone audiometric testing is important, but it is not within the scope of this discussion to describe the method of choice.

The importance of masking, especially when there is a marked difference in hearing in the two ears, cannot be overemphasized. Sound passes from one ear to the other by air at about a 50 db. difference in intensity even when headphones are used. When testing by bone conduction this transfer of sound occurs at about 10 to 15 db. through the skull bones. The most reliable method for avoiding this error is to constantly check with the patient concerning lateralization of sound. As long as the patient hears the sound in the ear being tested, we are on reasonably safe ground. This problem is of prime importance when dealing with unilateral conductive hearing losses and there is a question of surgical correction of the hearing defect.

Masking is imperative when there is a question of a complete perceptive hearing loss in one ear. In such cases a shadow hearing curve is obtained for the hearing in the defective ear. The curve is approximately 50 to 60 db. below that of the better hearing ear. With proper masking the true nature of the hearing loss can be brought out, and mistaken advice to the patient avoided.

A problem that is frequently encountered is whether bone conduction testing should be done in the presence of normal hearing. In order for this to be done accurately an excellent sound-treated room is necessary because normal hearing persons will have the bone-conduction signal masked by the environmental noises and therefore will respond at levels below that of the air-conduction curve. Testing of bone conduction is unnecessary in the presence of normal hearing because the nerve of hearing must ultimately transmit the sound to the brain for interpretation. When we encounter an audiometric graph with the bone-conduction curve below that of the air-conduction curve, we know that the error is in the testing facilities rather than in the auditory mechanism. This type of audiometric error also occurs with perceptive hearing losses. When the bone conduction is below that found by air, the error is in the calibration of the bone conduction receiver.

Configuration of pure-tone air and bone curves are typical for certain hearing losses; however, it is only when the audiometric curve is considered along with the history and physical findings that an etiologic diag-

nosis can be made. Some typical examples of conductive hearing loss curves which could not be differentiated from each other on the basis of the hearing curve alone are those due to foreign bodies of the external canal, dry tympanic perforations, chronic middle-ear disease, fluid in the middle ear, attic cholesteatoma, and otosclerosis. All of these could be confused with the pure-tone air-conduction curve of early Ménière's disease. Typical audiometric curves for perceptive losses are sometimes easier to differentiate. Some of these are hearing losses due to acoustic trauma, presbycusis, vascular spasm, arteriosclerosis, and congenital hearing loss due to Rh incompatability. Many errors in etiologic diagnosis will be made if these findings are not considered along with the history and physical examination.

Hearing testing for speech is of the utmost importance when surgical procedures are contemplated, in the differentiation of certain types of hearing losses, and when the use of a hearing aid might be indicated. The speech reception threshold is especially of use when checking on the accuracy of pure-tone air-conduction curves. It is generally considered that the loss for speech should equal the average loss at the frequencies 500, 1000, and 2000 in the air-conduction curve. If there is any marked deviation from this, possible sources of error should be checked.

Probably the most important test with word lists is the PB score, or discrimination score, which gives us a most accurate estimation of the patient's understanding ability. The PB score can be used as a check of the accuracy of the bone-conduction curve in much the same way as the speech reception threshold test is used as a check of the accuracy of the air-conduction curve. Discrimination tests are done at above threshold or at most comfortable hearing levels and therefore give us a prognostic view of the patient's ability to function after surgical correction of a hearing loss. Discrimination scores are also important when a hearing aid is considered. Two patients with equal perceptive losses by pure-tone curves may differ markedly in their understanding ability. The otologist will be able to properly advise the use of a hearing aid only when he has adequately determined the patient's discrimination with amplified sound. This is a responsibility which we as otologists must assume.

Another aid in diagnosis which is in the category of speech tests is the use of the telephone with special equipment for increasing the fidelity and intensity of the voice. Such an instrument is available as special equipment from the telephone company (hard of hearing telephone). If your office is equipped with more than one telephone and an intercom circuit, patients can be evaluated for their ability for understanding speech by changing the volume on this special telephone. The same type of evaluation can be made by use of a Brooks amplifier or by use of speaking tubes.

Summary

An understanding of basic hearing tests has become a necessity for the otologist in this day of rehabilitative and reconstructive otologic surgery. Current otologic and audiologic literature impresses the practicing physician with the concept that only expensive equipment and complicated hearing tests will enable him to make an accurate diagnosis. This thinking has taken diagnosis of hearing problems out of the hands of physicians and placed much of the responsibility with technicians in allied fields. I have demonstrated how the average otolaryngologist can adequately evaluate the majority of hearing problems without outside help. All that is necessary is accurate observation combined with an understanding of simple pure-tone and speech tests which can be easily accomplished with tuning forks and any commercial audiometer.

305 Baronne St. (12).

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Atrophic Rhinitis

Results of Surgical Treatment

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For many years surgeons have attempted to reduce the size of the airway in patients with atrophic rhinitis. Several different operations have been devised. Some surgeons, for example, have widened the nasal septum by implanting foreign substances or autogenous cartilage or bone. Others have moved the entire lateral wall of the nose inward. Most of these procedures have been abandoned because the results were not satisfactory or because the operation itself was too severe.

I have adopted the technique for narrowing the airway in which chips of iliac bone are placed in a subperiosteal pocket in the lateral wall of the nose. This method has been used by others and has been described before, but to my knowledge follow-up studies beyond the immediate postoperative period have not been reported.

Eight patients who had atrophic rhinitis and were treated surgically have been reexamined three years after their operations. The findings are reported here.

The Operation

1. *Anesthesia.*—The operation can be done with the patient under either local or general anesthesia. If local anesthesia is used, it is better to give more premedication than is customary for most otolaryngic operations. The removal of the hip graft is not painful, but the procedure is likely to be uncomfortable because of the jarring effect of mallet and chisel.

2. *Removing the Graft.*—When great strength is not necessary in a bone graft, cancellous bone is preferable to cortical bone because cancellous bone amalgamates with the host bone more readily. Furthermore, in this operation, since neither form nor rigidity of the graft is necessary, it is advantageous to use chips and slivers of bone since these can be more readily obtained than a single large piece. Also, the surgeon can insert chips of bone into the nose more easily than one large piece.

The anterior iliac crest can be readily exposed with the patient in the supine position. In children and young adolescents, the iliac crest is cartilage and not bone, and it is advisable, when removing bone from young patients, to preserve the cartilaginous epiphysis together with the attached muscles and later replace it.

In order not to make a scar directly over the bony prominence, the surgeon should retract the skin (either up or down) before he makes a 3 to 4 in. incision along the iliac crest. Some surgeons always make their incision on the left so that the scar will not later be mistaken for an appendectomy wound.

To avoid hemorrhage, it is well to inject a local anesthetic containing epinephrine before making the incision. It is also important in hemostasis to incise directly down to the bone and then carry out all additional dissection subperiosteally. Small pieces of bone wax may be used to stop persistent bleeding.

Because only cancellous bone is needed, it is not necessary to remove a full thickness of the iliac crest. Only the muscles attached to the outer table and the crest of the ilium are elevated. For this work a sharp periosteal elevator is best. Then with an osteotome, the iliac crest and outer table are cut through while the inner table is left

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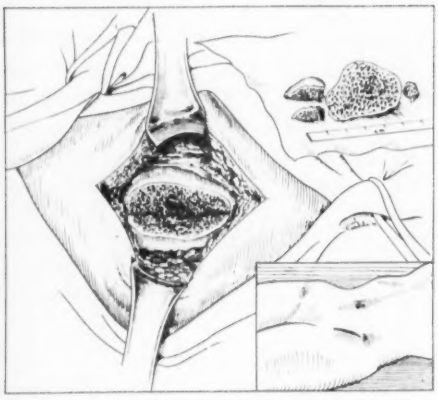

Fig. 1.—One method of obtaining cancellous bone from the hip. An effort is made to preserve part of the iliac crest for symmetry.

intact. This technique produces a hinge-like attachment of cortex and periosteum and allows the crest to be tilted back by a prying motion of the osteotome. Cancellous bone is then removed with a curved gouge from between layers of cortex. The pieces of bone are preserved in a gauze wet with saline. When adequate bone has been obtained, the cortical cap is replaced and the periosteum sutured. Soft tissues are closed in layers.

An alternative technique is to split the crest and remove the outer cortex of the ilium along with cancellous bone (Fig. 1). This method leaves the inner table and the inner half of the crest intact. Both methods preserve symmetry.

I have tried to obtain sufficient cartilage and bone from the nasal septum to use in a patient with unilateral atrophic rhinitis so that taking a hip graft would not be necessary. Unfortunately, this method provided insufficient grafting material and it was still necessary to remove additional bone from the hip. Nevertheless, one should remember that considerable supplemental bone and cartilage are available in the nasal septum, if the surgeon should take too little iliac bone and not wish to reopen the hip incision to get more.

3. *Preparing the Receptor Site.*—There is little to choose between an incision in the nasolabial fold (Fig. 2) and an intraoral incision made in the sublabial sulcus. The intraoral route seems to give a little better exposure than the nasolabial route and cannot produce a visible scar. Actually, the scar produced by an external incision in the nasolabial fold is usually not visible after a few months.

Again, local anesthetic containing epinephrine is used to infiltrate soft tissues, and an incision is made down to bone. The sharp edge of the pyriform crest provides a ready landmark for the surgeon as he begins to elevate periosteum from the lateral wall of the nose (Fig. 3). Sometimes it is helpful to remove a small amount of the pyriform crest by nibbling with a rongeur. This step makes periosteal elevation easier, and subsequently bone chips can be inserted with less danger of tearing the flap.

Normally, the inferior turbinate is firmly anchored to the lateral wall, but in most patients with atrophic rhinitis this turbinate is very small and only weakly adherent.

Fig. 2.—The scar produced by this incision is usually invisible after a few months. Exposure is adequate.

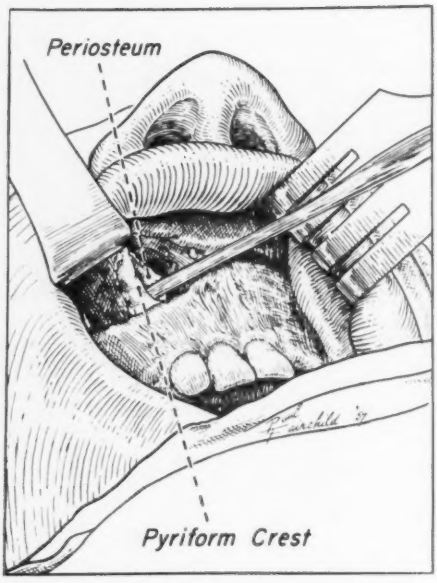

Fig. 3.—Sublabial incision showing reflection of periosteum. One incision serves for both sides.

Thus there is no difficulty in separating the inferior turbinate from the nasal wall. A submucous elevator or a small periosteal elevator is a good instrument for this work.

4. *Placing the Graft.*—When periosteal elevation seems sufficient, one may pack moist cotton into the pocket to determine how effective packing with bone will be. The cotton is then replaced with small chips and slivers of cancellous bone. It is a mistake to try to put in only one large piece of bone, because a large piece is likely to tear the mucoperichondrial flap. Also, a one-piece graft does not displace the soft tissues as well as several smaller pieces of bone. If a chip of bone is pushed through the mucosa into the nose it should be removed, but nothing need be done for the lacerated mucosa.

Cancellous bone is preferable to cortical bone, but one need not make an effort to remove every trace of cortex from the bone chips, and it is all right to use pieces of cortex if no cancellous bone is left. Figure 1 shows the bone removed (not yet cut into pieces) for use in a unilateral operation. This is a little more bone than is needed to fill one pocket but not quite enough for two.

The important thing, regardless of the type of bone chips, is to pack the pocket as full as possible and displace the mucoperichondrial flap (and the inferior turbinate) until it actually touches the septum (Fig. 4). One is likely to neglect to elevate periosteum directly above the inferior turbinate, and postoperatively this region may be the only part of the nose which tends to crust.

Sometimes patients are seen with unilateral atrophic rhinitis in whom the nasal septum is greatly displaced to one side. This septal deviation then appears to be the cause of atrophic changes in one side of the nose. If only crusting or bleeding, or both, are present and there is no great atrophy of the inferior turbinate, then realignment of the septum (without resection of appreciable cartilage or bone) usually corrects the symptoms and a bone graft is not necessary. But if the turbinate is markedly atrophic the bone graft operation should be done.

No packing is placed in the nose. When the surgeon creates an adequate pocket and then fills it sufficiently, there is no room for packing. Appropriate sutures of silk or catgut are placed in the skin of the nasolabial fold or in the sublabial mucosa, respectively.

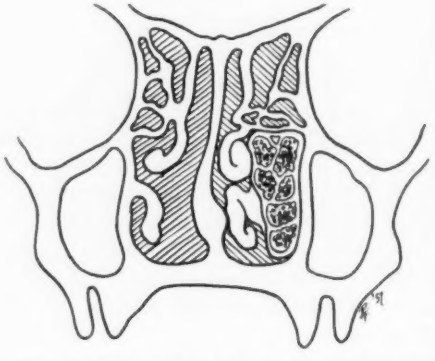

Fig. 4.—Bone chips placed in subperiosteal pocket. Inferior turbinate should touch septum.

5. *Postoperative Course.*—Patients experience more disability from the taking of the hip graft than from placing of the graft in the nose. They limp for a week or longer and are surprised at their trouble in walking unless they have been forewarned.

The nasal procedure is no more disabling than a submucous resection. Soft tissue edema completely occludes the nasal chambers for several days after the operation and then gradually subsides. Additional retraction of the lateral walls of the nose occurs for several weeks or months.

Evaluation of the Results

Each patient in this group of eight had a far-advanced disease process with great green crusts, bleeding mucosa, and ozena. Seven had bilateral disease and one had unilateral disease. There were four women and four men between the ages of 18 and 52 years.

All had used various forms of medical therapy but none had experienced permanent relief. Of the eight patients operated on, seven have had a satisfactory result for three years. The other patient has had to be reoperated on—apparently because insufficient bone was used as a graft or because more of the graft was absorbed than is usual.

Three of the seven patients who have satisfactory results continue to show very small yellow crusts high above the inferior turbinate. I think this minor crusting could have been avoided by elevating the periosteum more fully. None of the patients bleed, show green crusts, or have nasal odor.

The patients say that this is the first time they have been free of the symptoms of atrophic rhinitis since developing the disease. When asked, they say they are glad to have had an operation.

University Hospital (10).

Retrograde Intramucosal Hump Removal in Rhinoplasty

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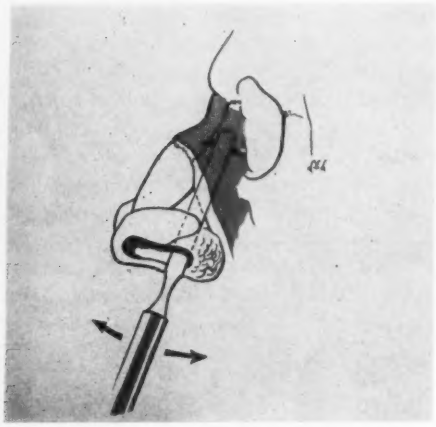

Fig. 1.—Widespread elevation of periosteum over nasal dorsum.

The purpose of this communication is to report a technique of retrograde intramucosal hump removal in rhinoplasty. This method is presented because, in our hands, it has proved more accurate, less traumatic, infinitely easier to teach and master, and is followed by considerably less hemorrhage and postoperative morbidity than is the case when the nasal hump is removed in the conventional manner with the Joseph saw or one of its many modifications. In addition, if the nasofrontal angle is abnormally shallow, deepening becomes a remarkably simple procedure.

Technique

After topical anesthetization of the interior of the nose, but *before* infiltration of the external framework, the amount of hump to be removed is carefully outlined on both sides with methylene blue, the effect of the amount of shortening to be done and the contemplated tip work being taken into consideration. The direction and location of the lateral osteotomies is also plotted.

After the skin overlying the upper lateral cartilaginous skeleton is elevated, the periosteum over the entire framework (nasal bones and ascending processes of the maxillae) is raised lateralward to a point beyond the line of the future lateral osteotomies and cephalically beyond the limits of the nasal dorsum to be removed (Fig. 1).

The nose is shortened the desired amount and any necessary tip work completed.

A submucosal tunnel is created on each side of the septum just under the upper lateral cartilages and the nasal bones (Fig. 2); the ventrodorsal extent of mucosal elevation depends on how much hump is to be removed. Construction of the tunnels is facilitated by using blunt dissection with Stevens scissors after the mucoperichondrial elevation has been started.

An attempt is made to disperse any edema which has accumulated in the tissue over the dorsum by applying pressure over the area for a few moments; this is feasible to a large extent because of the

Fig. 2.—Construction of bilateral subperichondrial and subperiosteal tunnels beneath the entire length of the cartilaginous and bony nasal dorsum.

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From the Eye, Ear, Nose, and Throat Hospital.

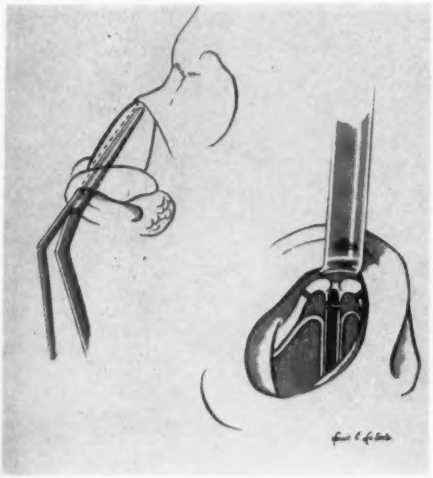

Fig. 3.—Intramucosal scissor cuts for removal of cartilaginous hump.

addition of hyalurinodase to the local anesthetic in the ratio of 75 units to the ounce.

One serrated blade of angulated cartilaginous hump scissors is then placed in each tunnel, and the septum is cut along a line parallel to the cephalic portion of the previously mentioned methylene blue guide marks (Fig. 3). How far cephalically under the nasal bones the septum can be cut with the angulated scissors depends on how large a hump is present; after we have gone as far as space permits with the scissors, it is our custom to try to gain a few millimeters by using Mayo scissors, whose blades are acutely tapered; in this way, we are usually able to cut the septum for varying distances under the bony dorsum.

Each upper lateral cartilage is then cut to conform to the desired profile with the angulated hump scissors. However, they are cut at a level which is slightly more ventral than the previously cut septum in order to compensate for the loss of projection of narrowing the nose. The scissor cuts extend cephalically to the caudal margin of the nasal bones.

If the soft tissues are elevated at this time, one will see the cartilaginous portion of the hump cut away from the septum and the upper lateral cartilages but still attached to the nasal bones (Fig. 3).

The technique used to remove the bony portion of the hump depends upon its size and/or the necessity for deepening the nasofrontal angle.

When the hump is small and no nasofrontal angle deepening is necessary, a Neivert hump gouge is introduced up to the caudal end of the nasal bones, the lower portion of the curve resting on the ventral portion of the septum and the upper portions of the curve engaging the nasal bones in a position determined by the previously made scissor cuts in the upper lateral cartilages. The gouge is directed parallel to the methylene blue lines, and, usually, but a few light taps are necessary to remove the bony hump and its underlying septum. The entire hump, bony and cartilaginous and underlying septum, is then easily extracted in toto with a hemostat.

If the bony hump is large, a Neivert guarded lateral osteotomy chisel is introduced into the farthest extent of the cut in the upper lateral cartilage on one side until the caudal end of the nasal bone is engaged. The chisel is directed parallel to the methylene blue line and is tapped lightly with a metal mallet while one finger is held on the subcutaneous guard for the purpose of

Fig. 4.—Hump removal osteotomies performed with Neivert lateral osteotome.

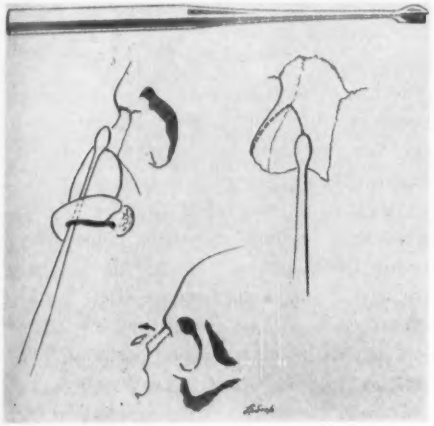

Fig. 5.—Completion of hump removal with Neivert hump gouge.

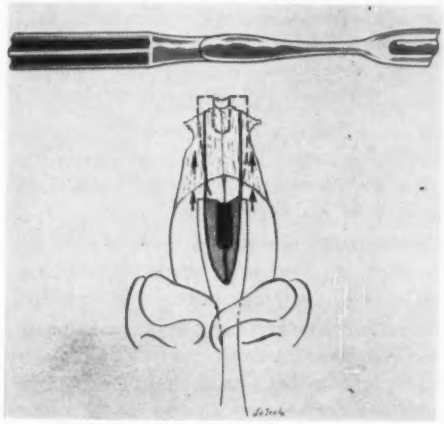

Fig. 6A.—Preoperative view of a typical hump deformity.

Figure 6B.—Postoperative view of patient following hump removal with technique described. Note deepening of nasofrontal angle.

checking the direction the instrument is following (Fig. 4). The same procedure is repeated on the other side. Removal of the septal portion of the hump under the nasal bones is then completed with the above-mentioned Neivert hump gouge (Fig. 5).

Deepening of the nasofrontal angle is easily accomplished by directing the chisel to the desired depth and then rocking the hump from its cephalic attachment with the Neivert hump gouge. The bone fractures readily, and the hump can be extracted with little difficulty.

Central and lateral osteotomies are then performed with chisels, and the nose is narrowed.

Comment

We have noted numerous advantages to this type of hump removal.

Hemorrhage is minimal because most of the work is done intramucosally; we say "most" because, unless one elevates the mucosa laterally from the under surface of the nasal bones, a small amount of mucosa will be left in that area. Thus, the mucosa under the dorsum remains uncut—a condition which reduces hemorrhage during the operation and the amount of unpredictable scar tissue contraction and adhesion formation postoperatively. Some may feel that the presence of excess mucosa would cause widening of the nose following the operation. Such has not been our experience; consequently, we feel that the mucosa must either contract or adjust itself to the new dimensions of the interior of the nose.

The use of skin markings in rhinoplastic surgery is admittedly a controversial question. We feel, however, that they are of definite value provided hyaluronidase has been used with the infiltration anesthetic, the tissue is "milked" of edema before performing the maneuvers for which they are used as a guide, and they are used in the manner we describe. Regarding the latter point, it will be noted we recommend that, after the "milking" procedure, the direction to be taken by the angulated scissors in the

Fig. 7A.—Preoperative view of another patient with a typical hump deformity.

Fig. 7B.—Postoperative view of patient following hump removal with technique described. Note that nasofrontal angle was deepened about one-fourth inch.

removal of the cartilaginous hump is determined by aligning it with the cephalic end of the markers, i. e., the markings over the nasal bones. The caudal portion of the nose is, of course, distorted by the introduction of the scissors, and, one might be misled by the markings over this area were they to be used as a guide; such is not the case when the cephalic portions of the markings are used. When the bony hump is being reduced, the same markings may be used, inasmuch as the Neivert lateral osteotomy chisel is so constructed that it distorts the tissues little, if any.

We contend that this method of hump removal is less traumatic than the usual saw type because only a few light taps of a mallet are needed, and, since the force is applied in a straight line, there is no problem of lateral vibration and no need to take vigorous measures to steady the head. Such lateral vibration and repetitive stretching of the tissue as a result of the excursions of the saw is definitely traumatic and contributes, in large measure, to postoperative edema and hematoma; this is particularly true when the elevation of the periosteum over the nasal bones and the ascending processes of the maxillae is not continuous.

Removal of the cartilaginous hump first helps to eliminate to some extent the possibility of obtaining the tall too familiar "bird's beak" deformity which develops postoperatively after the tip has supposedly "dropped"; in reality, this condition is due to insufficient removal of cartilaginous dorsum. One reason for such faulty removal is the fact that in traditional hump removal one must traverse nine distinct layers of tissue simultaneously with a button-end knife; it is necessary to traverse only one or two layers at a time when this method is used. In this connection, it might be well to mention that, should it become necessary to trim the septum a little more at

the end of the operation, this can be easily accomplished because it is denuded of membrane bilaterally and stands well exposed when the skin overlying the dorsum is elevated.

Neivert [1] has pointed out the necessity of removing the septum at a lower level than the nasal bones and upper lateral cartilages. This requirement is met in this technique.

To master the use of the saw, one must train and perfect his movements much as a golfer must practice stance, grip, and swing; not holding the elbow at the proper height, failing to deliver the force through the shoulder, or allowing the plane of the saw cut to become angulated will prejudice results. In this method, all that is required is to be able to direct a straight instrument along a straight line with the added help of being able to follow the progress of said instrument with the finger as well as the eye. Thus, it is much easier to teach this type of hump removal than it is to teach removal with the saw, and the student invariably approaches it with a great deal more confidence of success.

If the nasofrontal angle is shallow, it is generally recommended that deepening be done before the hump is removed by the saw. This is technically very difficult, time-consuming, and laborious; when the technique outlined above is employed, the angle is treated as part of the hump and is easily, quickly, and completely removed with little extra effort.

Conclusions

Our experience with retrograde intramucosal hump removal in rhinoplasty leads us to believe that this technique has a place in our technical armamentarium. In comparison with traditional methods, we have found that its use permits hump removal with a greater degree of accuracy and predictability, that it is accompanied and followed by less hemorrhage, edema, and hematoma formation, that it is less disturbing to the patient, and the postoperative course is a great deal smoother. Additionally, it is particularly helpful when deepening of the nasofrontal angle is required.

305 Baronne St. (12).

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Chronic Maxillary Sinus Disease

A Report of Thirty-Three Caldwell-Luc Operations Performed in 1955-1956

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This is a report of 33 Caldwell-Luc operations performed during 15 consecutive months of 1955 and 1956 by the staff serving a bordering area of over 150,000 people. It is of particular interest in view of the number of radical sinus operations performed in a 15-month period, and the variety of pathology present.

We have not included chronic maxillary sinus disease cases successfully treated medically or with less extensive surgery, such as antrum windows, or those complicated by other paranasal sinus infections. We have not at any time in the years prior to this series or since then had so many cases come to surgery during such a short period of time.

From an excellent article by Boies[1] I should like to reemphasize the following points: "A chronic sinus condition is one in which changes have occurred in the sinus mucosa that are irreversible spontaneously, which if unaided surgically will persist in the form of hyperplastic change, fibrosis, or actual membrane necrosis. . . . There is unanimous agreement that the Caldwell-Luc approach gives better visualization and more complete removal of grossly diseased membrane and enables one to fold the mucosal flap over the cut bone."

In every case we endeavored to avoid radical surgery where possible by conservative treatments—such treatments extending from 3 months to 24 months, depending upon what that case had dictated. These included the following: removal of obstruction to normal paranasal sinus ventilation, which included treatment of anatomical obstructions such as deviated nasal septum, nasal polyps, cauterization of turbinates; complete allergy studies when indicated by skin tests to pollens, foods, and contacts; autogenous vaccines, elimination of contact and food sensitivities, and desensitization; complete dental evaluation by an oral surgeon; treatment of any systemic disease by the local physicians. Specific treatment was carried out by a Proetz displacement, irrigation of the antrum through its natural ostia, and by needle puncture. All were evaluated with sinus x-rays and contrast studies with iodized oil (Lipiodol). The iodized oil films were taken at 24, 48, and 72 hours to evaluate not only local pathology, but also the physiological emptying of the antrum. Follow-up x-rays were taken when indicated.

These cases came to surgery when the above conservative methods of treatment for chronic maxillary sinusitis failed, for removal of cysts, for chronic suppuration of dental origin, for chronic maxillary sinusitis complicated by oroantral fistula, and for malignancy of the antrum. All diseased tissue and tumor tissue was examined by the pathologist postoperatively. Each case has had a 24- to 36-month follow-up. In only two cases was there any postoperative sensory disturbance, and these became asymptomatic in four and six months respectively.

Report of Cases

CASE 1.—A 47-year-old female Nespelem Indian had had an intermittent ache in the region of her left upper molars of six months' duration. She had one tooth pulled without any relief. Examination revealed the left antrum to be black to

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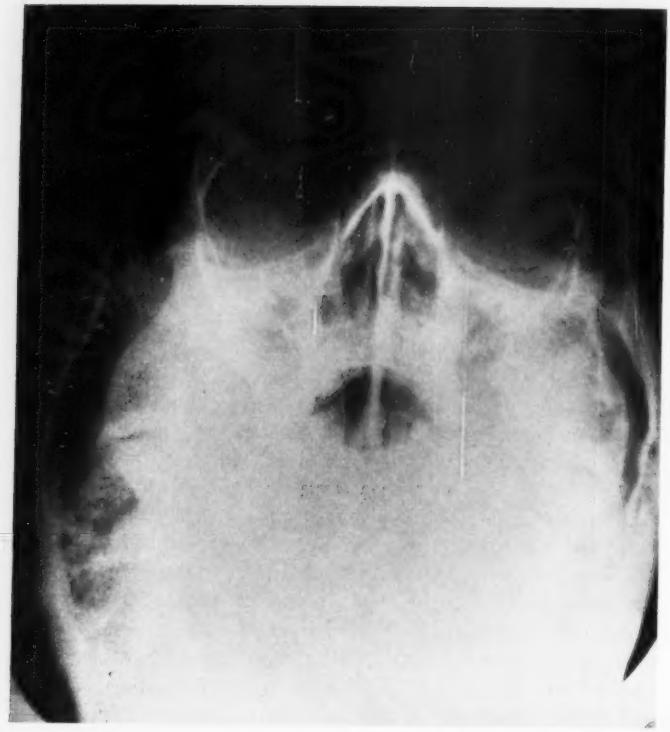

Figure 1

transillumination. There was a septal deviation to the right, with some compensatory atrophic rhinitis on the left. Irrigation of the left antrum produced approximately 15 cc. of a foul purulent material. X-rays (Figs. 1 and 2) with contrast iodized oil studies revealed a tumor of the left antrum with destruction of its lateral wall. True to form to our past experience with Indians, she did not return for her scheduled surgery for over two and a half months. At this time the Caldwell-

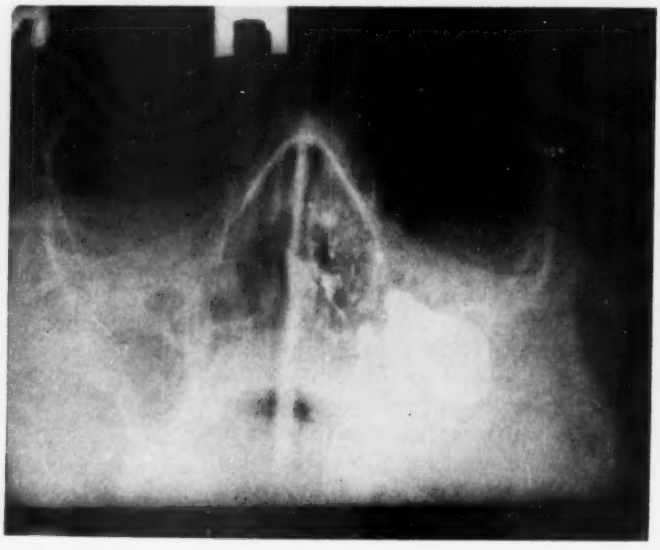

Figure 2

Luc operation was performed. A pathological diagnosis of anaplastic carcinoma, Grade 3, which the pathologist stated was extremely invasive and far advanced, made future radical surgery seem improbable. She was, therefore, treated with 3500 r per port by a local radiologist. However, the carcinoma progressed, and she died within nine months.

Comment.—There is no argument that the treatment of choice of cancer of the paranasal sinuses is radical surgery followed by irradiation, that the best cure rate is hereby obtained as pointed out by Frazell.[2] Tabb's[3] series substantiated the fact that the highly malignant tumors, because of their properties of invasiveness and infiltration, are attended with a lower rate of cure, no matter how they are treated. Had this patient followed advice when first seen, and, more important, had she been receptive to radical surgery including maxillectomy and removal of orbital contents, perhaps she would have survived a few extra months. It has been our sad experience though, in dealing with Indians during the past 18 years here, that, regardless of what you advise or do, they will not carry through on any program. In this sense they are still in a category by themselves.

Case 2.—A 49-year-old housewife had been treated by us and by specialists in Seattle for the past nine years for trigeminal neuralgia, severe attacks occurring two to four times a month. She had had repeated alcohol injections and a severance of the right infraorbital nerve. None of these treatments, however, offered more than 4 to 12 months' relief. Although her sinuses were always clear to transillumination, we thought it advisable to completely evaluate them before considering other types of surgery on the nerve itself. Sinus x-rays revealed a thickening of the mucous membrane of the right antrum. Iodized oil studies (Fig. 3) revealed good filling of the antrum but poor physiological function, as evidenced by the presence of dye at 96 hours. On the basis of this, it was found that a Proetz displacement or a direct irrigation through the natural ostia gave complete relief of the neuralgia, each time mucopurulent material was obtained. This was tested on three different attacks of maxillary sinusitis with neuralgia before the patient had her Caldwell-Luc operation. At surgery there was a generalized thickening of the mucous membrane and an erosion of the bone into the pterygoid fossa. Pathological diagnosis showed chronic inflammatory tissue, polypoid mucosa with retention cysts. The patient has not had one recurrence of neuralgia in the two years postoperatively.

Figure 3

Case 3.—A 10-year-old white boy was brought in to the oral surgeon by his mother, seeking an explanation of the painless, progressive swelling over the right maxillary area of several months' duration. Examination revealed a downward and lateral displacement of the adjacent teeth. There was noticeable swelling over the lower right maxillary region of the face. The x-ray (Fig. 4) revealed a large cystic lesion occupying the major part of the right antrum. A tooth, apparently the right maxillary cuspid, was located in the medial superior region of the antrum. The impression was that it was a dentigerous cyst. This was removed at surgery along with the tooth. Grossly, this was an edematous fibrous walled cyst 4.5 cm. in length, the wall averaging 35 mm. in thickness. The inner lining was composed of granular pink tissue with a few pale areas. The crown of the tooth was protruding into one end of the cyst. Microscopically the lining consisted of acute and chronic inflammatory granulation tissue with remnants of squamous epithelium at many points. There was no evidence of malignancy in this material. The pathological diagnosis was dentigerous cyst of the right maxilla. The boy has made an uneventful recovery, with no evidence of recurrence in two years.

Case 4.—A 56-year-old white man was first seen with the chief complaint of extremely foul drainage into the mouth from the left upper molar area of three months' duration. Irrigation produced approximately 15 cc. of very foul purulent ma-

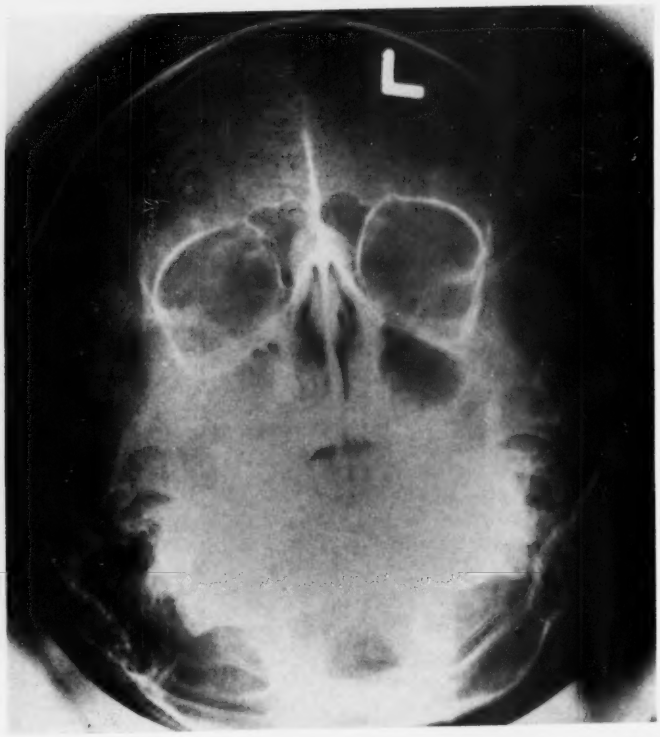

Figure 4

Figure 5

Figure 6

terial. X-rays studies with iodized oil (Fig. 5) revealed a chronic maxillary sinusitis with an oro-antral fistula. This was repaired at the time of the Caldwell-Luc operation. The pathological diagnosis confirmed the clinical diagnosis. He has not had any recurrence of symptoms in the past two and a half years.

CASE 5.—A 23-year-old white man was referred to us with a history of recurrent upper respiratory infections progressing to pneumonia on seven different occasions during the previous five years. Examination revealed a severe deviation of the nasal septum with multiple nasal polyps bilaterally and chronic tonsillitis. Nasopharynx examination revealed an abundance of purulent material. The antrums were hazy to transillumination. Sinus x-rays revealed a thickening of the lining of both antrums. Contrast films (Fig. 6) confirmed this and revealed filling defects along the anterior and inferior walls. The initial program consisted of cleaning up the infected sinuses, a tonsillectomy by the family doctor, a submucous resection, a nasal polypoidectomy, and autogenous vaccine desensitization. In spite of all this treatment, the patient continued to have trouble. We were unable to clean up the chronic maxillary sinusitis. It was not until he had the bilateral Caldwell-Luc operation, the right side being done, incidentally, five months prior to the left, that he finally received lasting benefit. A follow-up check with the family doctor revealed that he has not had any lung trouble in the past year and a half, and his general health has been excellent.

CASE 6.—A 20-year-old woman student at the University of Washington gave a history of intermittent swelling of the right eye of one to three days' duration, with accompanying right otalgia occurring every four to six weeks of one and a half years' duration. She also had a history of nasal congestion of many years' duration. Examination by the ophthalmologist revealed normal vision. There was quite a marked degree of protrusion of the eyeball due to the retrobulbar edema, and also edema of the lids. A severe deviation of the nasal septum to the left with a complete union of the mucous membrane overlying the inferior turbinate with that of the bony septum was present. Findings in the right nostril were very suggestive of an atrophic rhinitis. However, after anesthetization of the nose prior to submucous resection, so many, many adhesions and such an abundance of scar tissue were found to be present that further questioning revealed, "A doctor irrigated both nostrils with 10% silver nitrate solution on three different occasions, which was extremely painful." If this is true, it certainly accounts for the bizarre findings in the nose. The submucous resection was completed, and the adhesions severed. Iodized oil contrast studies (Fig. 7) of the right antrum revealed a chronic maxillary sinusitis, as evidenced by the filling defect. However, she was treated at first strictly as an allergic patient, as her history

Figure 7

and findings were more consistent with bacterial sensitivity. She showed some improvement, but continued to have recurrent episodes. We finally performed a Caldwell-Luc operation on the right antrum, which revealed an abundance of polypoid tissue. She has been on her autogenous vaccine shots since then and has done exceptionally well. There has not been any recurrence of the edema in the past two years.

Comment.—This is one of the many cases in this report of a very allergic individual with maxillary sinus disease in which a cure would not be accomplished solely on

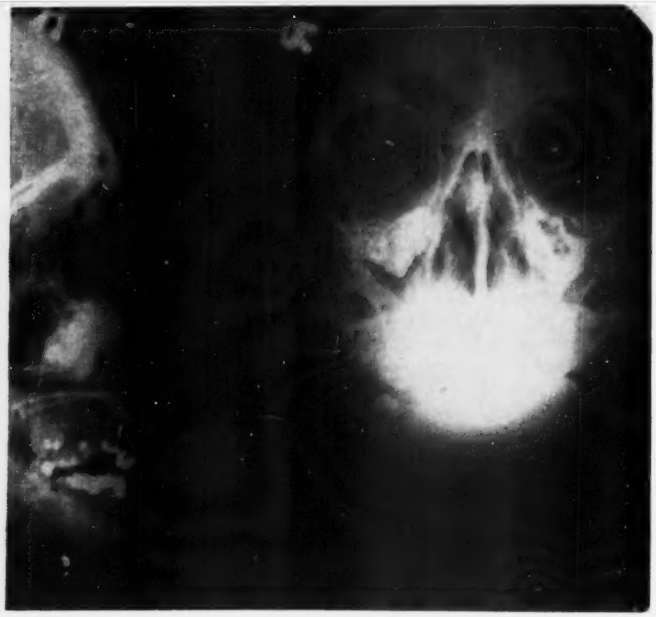

Figure 8

Figure 9

the basis of allergy without surgery, as noted by Sanders [4] and by Surber [5] in a report of 65 cases of chronic bacterial allergy of the paranasal sinuses.

CASE 7.—A 44-year-old white woman complained of intermittent plugging of the left ear of seven years' duration, with accompanying aching over the antrums. During the four months prior to her Caldwell-Luc operation she was treated with inflations of the Eustachian tube, allergy medication, and iodized oil studies (Fig. 8) of the antrums, which were cloudy to transillumination. The latter revealed extremely poor physiological function, iodized oil being present for 6 days following instillation in the right antrum and 10 days in the left. She also had a dental evaluation and correction of her bite. The pathological diagnosis of polypoid mucosa showing chronic inflammatory reaction from the right antrum plus a complete alleviation of symptoms for two and a half years postoperatively, confirms the preoperative opinion, namely, that of the important role played by the chronically diseased antrum in this patient's illness.

CASE 8.—A 31-year-old woman physician for a period of approximately one year had extremely vague intermittent symptoms of pressure referable to the right antral area. On the suspicion of abnormal findings of dental x-rays, we obtained sinus films (Fig. 9). They revealed a large cyst present in the right antrum. Surgery proved this to be a large well-formed dentigerous cyst, completely filling the right antrum and eroding the lateral wall. The patient has made an uneventful recovery and been asymptomatic to date.

CASE 9.—A 43-year-old white man was first seen in May, complaining of an extremely foul discharge entering the mouth from the left antrum since he had had a left upper second molar tooth extracted five months previously. Examination revealed chronic maxillary sinusitis on the left side with an oroantral fistula. This was confirmed by x-rays (Fig. 10). The fistula was repaired simultaneously with the Caldwell-Luc operation, and he has remained asymptomatic with no evidence of recurrence two years postoperatively.

Comment.—The excellent diagnostic aid of contrast studies is pointed out by Bennett and Moore [6] in a report of 29 cases of oroantral fistulae.

CASE 10.—A 32-year-old white housewife had frequent frontal headaches and pain over the right antrum, intermittent and nonseasonal in character, of approximately 10 years' duration. Examination failed to reveal any underlying allergy as one of

Figure 10

the contributing factors. The antrums were hazy to transillumination, however. A sinus x-ray revealed a thickened lining of the frontal and maxillary sinuses. There was also a small filling defect on the medial inferior wall of the right antrum. Iodized oil confirmed this filling defect. A Caldwell-Luc operation on the right revealed an exostosis in the area described on the x-ray and a moderate thickening of the mucous membrane, which is described as chronic inflammatory tissue by the pathologist. She has only had two or three headaches in the two and a half years postoperatively.

Case 11.—A 34-year-old white woman had a history of chronic maxillary sinusitis on the right with recurrent attacks of acute sinusitis, all accompanied by headaches located above the eye, over the cheek, and in the upper teeth, of six years' duration. This was confirmed by x-rays. There was very little iodized oil present in the antrum, revealing almost complete obliteration of the antrum. At surgery the antrum was almost completely filled with thick polypoid tissue. She has been asymptomatic three years postoperatively.

Case 12.—A 41-year-old man complained of complete nasal obstruction of one year's duration and an extremely foul postnasal discharge of three years' duration. Examination revealed a severe deviation of the nasal septum and multiple polyps bilaterally, plus a chronic maxillary sinusitis on the right. Removal of the polyps and correction of the deviated septum did not, however, stop or decrease the foul postnasal discharge. A Caldwell-Luc operation was performed, revealing the antrum almost obliterated by chronically infected polypoid tissue. Since this, the patient has remained asymptomatic for two years.

Case 13.—A 40-year-old white woman was seen for a recurrent otalgia of the right ear of nine years' duration. This was also accompanied by tinnitus, all of which was aggravated by her hay fever each fall. Before coming to us she had a a nasal polypectomy and three radium treatments to the Eustachian tubes. During the past three years she had also had intermittent but progressive difficulty with sinus infections. The right Eustachian tube had always been and still was extremely difficult to inflate. X-rays and iodized oil studies revealed a chronic right maxillary sinusitis. At surgery the antrum was filled with polypoid tissue. Pathological diagnosis was polypoid and chronic inflammatory tissue from the right antrum containing cysts and areas of granulation tissue. The patient has done very well a year and a half postoperatively. The aching of the right ear has been controlled easily with occasional inflations of the Eustachian tube.

Case 14.—A 52-year-old white man complained of pain and tenderness over the right cheek of six months' duration following an upper right second molar extraction. Examination and preoperative x-rays revealed chronic maxillary sinusitis, which was confirmed at time of surgery and by the pathological examination. He has been asymptomatic during the two years postoperatively.

Case 15.—A 45-year-old white man was referred to us for evaluation of recurrent epistaxis of two weeks' duration. We were able to control this on several occasions during the week by the usual methods. Most of the bleeding was coming from Kiesselbach's area on the right and also from the posterior tip of the inferior turbinate on the right. Since there was some question of the antrums being the source of the bleeding, we obtained sinus x-rays, which revealed some cloudiness of the antrum. Iodized oil, however, revealed an irregularity along the anterior inferior margins suggestive of a tumor. At the end of 48 hours the findings were the same. None of the iodized oil had emptied at this time. The impression by the radiologist was that of poor physiological function and polypoid tissue or tumor in the right antrum. A Caldwell-Luc operation was performed, revealing the antrum to be filled with polypoid tissue, some of which was quite suspicious of malignant changes. Pathological diagnosis, however, was chronic inflammatory tissue from the right antrum containing mucous retention cysts. This patient did very well postoperatively up to the time of his death due to other causes.

Case 16.—A 28-year-old white man complained of intermittent headaches of eight years' duration, so severe that they were often accompanied by nausea and vomiting. He had a history of hypertension, and more than 20 doctors that he had

consulted in the eight-year period had attributed the headaches to the hypertension; yet the history more closely resembled the histamine type of cephalgia. Initial examination revealed a blood pressure of 194/144. The sinuses were cloudy to transillumination. There was a deviation of the nasal septum to the left. Intravenous histamine failed to produce a headache. The sinus x-rays revealed the frontal and maxillary sinuses to be quite cloudy throughout. Proetz displacement with iodized oil revealed normal filling in all paranasal sinuses with the exception of the left frontal and right antrum. An area in the right antrum appeared to be a polyp or mucocele. Less than 0.5 cc. of iodized oil entered the left antrum, revealing it to be almost completely filled with a soft tissue deformity. There was some suspicion of bony erosion. Because of the duration of the symptoms and the difficulty associated with handling this patient because of his emotional immaturity, we attempted to control him medically. He was put on a restrictive diet, antihistamines, and iodides. The next severe attack was controlled very adequately with 5 cc. of diphenhydramine (Benadryl) hydrochloride, I. V. Because of this response and his history, we started histamine desensitization, to which he responded very well. After eight months he had a gradual return of his headaches and was quite concerned over the possibilities of malignancy in the sinuses. The symptoms of sinus infections and headaches gradually returned. It was the consensus of opinion that the chronic infection and/or growths in the antrums must be removed. A Caldwell-Luc operation on the left side was performed, revealing a severely diseased mucous membrane throughout, and all of the antrum filled with polypoid tissue. The right antrum was bad, but not to such a degree. Pathological diagnosis was that of chronic inflammatory tissue with no evidence of malignancy. He has had three acute upsets in the two years postoperatively, all of which were precipitated by an upper respiratory infection. His general physical health and mental outlook have been greatly improved. He has gained 15 lb. since surgery, and his blood pressure is lower.

Case 17.—A 44-year-old white man had a history of left maxillary sinusitis and oroantral fistula from childhood. He had not received any treatment. He has had recurrent attacks of acute sinusitis throughout his life. He had a history of iritis, and on two different occasions examination of the head and neck revealed a chronic maxillary sinusitis on the left. The oroantral fistula had closed quite completely, as evidenced by iodized oil x-ray studies. A Caldwell-Luc operation revealed the antrum to be filled with an abundance of polypoid tissue and chronic inflammation of the mucous membrane. He has had one recurrence of the iritis during the past year, but has been asymptomatic with regard to the recurrent sinusitis.

Case 18.—A 60-year-old white man complained of an intermittent dull pain over the left antrum following a tooth extraction two months previously. X-rays revealed a chronic maxillary sinusitis, which was confirmed at time of surgery and by pathological examination of the diseased tissue. He has been asymptomatic for two years postoperatively.

Case 19.—A 43-year-old white woman complained of daily headaches on the left side of the face of 10 years' duration. She had been treated with some 50 or 60 antrum irrigations by other physicians. Examination revealed a chronic left maxillary sinusitis. There was no evidence of other contributing factors such as allergy, or obstructing factors such as a deviated septum or nasal polyps. The antrum was almost completely filled with polypoid tissue, and the mucous membrane revealed chronic infection. She has been asymptomatic for 18 months postoperatively, with no evidence of recurrence.

Case 20.—A 50-year-old white woman complained of a sore throat of three years' duration. It was nonseasonal in character. She had run the usual gamut of antibiotics from various physicians over the three-year period without any relief. We found that she had a chronic maxillary sinusitis, marked elongation of both styloid processes, and a bacterial allergy. The latter was treated with autogenous vaccine following a Caldwell-Luc operation, which revealed the antrum to be filled with polypoid tissue and chronic inflammatory mucous membrane. Continuing her autogenous vaccine, she has remained asymptomatic for the past two years. The styloid processes, in spite of their marked elongation, were not thought to play a very important role in this case.

Case 21.—A 15-year-old white girl had been having intermittent pains in the nose and ears for the past three years. During this time she was treated with Proetz displacement and antrum irrigations when indicated for a chronic right maxillary sinusitis, the drainage of which was resulting in a marked hypertrophy of the lymphoid tissue in the nasopharynx, as revealed by nasopharyngoscopy at time of initial examination. Over the three-year period prior to surgery these treatments were kept up. However, the infection in the right antrum became progressively worse—the material obtained by irrigation that was mucopurulent now becoming a thick, foul, green material. At surgery the antrum was filled with pus and granulation tissue, which confirmed the findings of the x-ray, iodized oil series of the right antrum showing a marked filling defect and very poor physiological functioning. Pathological diagnosis was that of polypoid mucosa and acute and chronic inflam-

matory tissue. During the two years postoperatively she has been seen once for a cold of short duration. She has not had any recurrence of the otalgia or nasal congestion.

CASES 22 and 23.—These were young white women in their 20's, both of whom were referred to us for their chronic sinusitis. Both cases resolved into a chronic maxillary sinusitis, which did not respond to the usual medical treatments, Proetz displacements, and antrum irrigations; and ultimately the patients came to radical sinus surgery. Since that time, 18 months and two years postoperatively, they have both done very well in regard to their sinusitis.

CASE 24.—A 31-year-old white man was seen for a nasal obstruction and chronic postnasal drainage of many years' duration. Examination revealed bilateral polyposis, a chronic maxillary sinusitis, and a nasal allergy. He responded well to desensitization with house dusts and molds and early and late pollens, plus a nasal polypectomy. However, the chronic maxillary infection continued unchanged despite all forms of treatment. Since a Caldwell-Luc operation he has done exceptionally well for the past one and a half years postoperatively, during which time he has had but one attack of acute rhinitis and sinusitis of one week's duration.

CASE 25.—A 29-year-old white man came to the office seeking treatment for tinnitus and deafness of the right ear of 11 years' duration following a blow on the head at Okinawa during World War II. Examination revealed not only the traumatic deafness but also a chronic maxillary sinusitis. Further questioning revealed that he had had an extremely foul postnasal discharge for over one year. This case did not respond to treatment of the infection and nasal congestion. Involvement of the antrum was marked, as revealed by the iodized oil studies of the sinus, and a Caldwell-Luc operation was performed, which stopped the foul postnasal drainage. He has not had any recurrence for the past 18 months.

CASE 26.—A 47-year-old white woman was first seen complaining of sinus trouble of 10 years' duration. She had had innumerable antral washings through the normal ostia and by puncture by innumerable physicians. However, she had continued to have intermittent acute attacks characterized by pain and headache, with plugging of the ear on that side. Irrigation of the antrum produced several small, greenish clumps of pus and debris. X-ray studies revealed the right antrum to be quite cloudy. Iodized oil instillation revealed a smooth filling defect at the base of the antrum which extended to the posterior wall. Follow-up irrigations produced 5 to 7 cc. of pus each time. Over a period of the next four months she continued to have recurrent acute attacks of maxillary sinusitis. Each time irrigation would produce 12 to 15 cc. of yellowish-green material. In view of the 10-year history and lack of response to more conservative measures, a Caldwell-Luc operation was done. The antrum was filled with pus and granulation tissue. Pathological diagnosis was chronic inflammation and polypoid mucosa of the antrum. She has not had any acute attacks in the two years postoperatively.

CASE 27.—A 57-year-old white woman was referred to us by her family doctor for help in treatment of her allergies and sinus infection, both of which were aggravating her chronic bronchial asthma and bronchiectasis. She was an extremely allergic person. Through the use of cortisone her family doctor was able to bring her weight back up from 80 lb. to 120 lb. However, the recurrent sinusitis and allergic upsets greatly aggravated her pulmonary difficulties. Our examination revealed a deviation of the nasal septum and a chronic maxillary sinusitis bilaterally. This severe allergic rhinitis was treated over a period of 10 years prior to her radical sinus surgery. She had complete skin tests and desensitization with autogenous vaccine. She had numerous x-rays of her sinuses and chest. The sinus x-rays always revealed very complete obstruction of the antrums by polypoid tissue, as evidenced by the presence of less than 1 cc. of iodized oil. The family doctor felt that in the final analysis surgical treatment of the chronic sinusitis would be of benefit, and we were in agreement with him. Both antrums were completely filled with polypoid tissue and chronic inflammatory tissue. A nasal polypectomy was performed also. She has had less difficulty in the two years postoperatively with the recurrent sinusitis, but she is continuing to be a problem to handle in regard to the allergy. In retrospect, because of the extreme amount of allergy present, I do not believe that this woman would have come to surgery if it had not been for the fact that over a period of 10 years of continual treatment her condition was always aggravated by the recurrent maxillary sinusitis, which was alleviated by Proetz displacement and antrum irrigations.

CASE 28.—A 53-year-old white man was first seen one month prior to surgery, complaining of nasal obstruction of five months' duration. Examination revealed a very marked allergic rhinitis. The left antrum was black to transillumination; the right was hazy. Irrigation of the left antrum failed to produce any mucoid or purulent material. Sinus x-rays revealed a large mass on the lateral inferior wall of the left antrum. Iodized oil showed only a small filling defect along the anterior wall. This patient was skin-tested and found to be extremely sensitive to dusts and molds and was started on a course of desensitization.

Because of the question of malignancy a Caldwell-Luc operation was performed, revealing the antrum to be almost completely filled with polypoid tissue. His allergy program has been continued for the past two years, and he has been extremely well.

CASE 29.—A 44-year-old white man was first seen here five years prior to surgery. He was referred to us for treatment of headaches which he had had many years and which had become increasingly severe during the past two years. He had chronic tonsillitis, allergic rhinitis with a secondary bacterial infection, and a paranasal sinusitis. He responded very well to house dust and molds desensitization. His headaches ceased to be a problem. He was seen five years later complaining of nasal congestion. Examination revealed rhinitis medicamentosa secondary to 1% phenylephrine hydrochloride (Neo-Synephrine) drops daily for the past year. The antrums were very black to transillumination, and the tonsils were, of course, still chronically infected. In the ensuing months the sinuses were washed out and evaluated with iodized oil. He had a local tonsillectomy. Because of the very poor physiological function of the right antrum and the appearance of an irregular thickened lining, a Caldwell-Luc operation was done and a window with the mucous membrane flap placed over the bone, as we have done in all previous and subsequent cases. He later had a submucous resection and he has been in good health two years postoperatively, with no recurrence of the sinusitis, nasal congestion, or headaches.

CASE 30.—A 65-year-old male physician had chronic bronchial asthma, emphysema, and a chronic right maxillary sinusitis. His asthma became progressively worse over a period of five years, despite medical treatments, including vaccines and elimination. A Caldwell-Luc operation was done, which revealed the right antrum to be almost completely filled with polypoid tissue. Pathological diagnosis was that of chronic inflammation of the mucosa and polypoid tissue. He has been somewhat better since the surgery and has been able to return to a limited practice.

Comment.—In regard to this type of case, Goldman[7] and others did an extensive study on the relationship of sinus disease and asthma on 82 patients in a follow-up study of sinus surgery and 61 patients that had been selected for operation because of persistent sinus disease with abnormal membrane. In conclusion they stated that sinus infection as a rule is a complication superimposed on an altered sinus membrane and is not a primary cause of asthma, and that the management of sinus disease should include at first conservative measures and later such surgery as indicated by local nasosinal abnormalities and by persistent infection. I believe this course of action is quite generally agreed upon.

CASE 31.—A 44-year-old white woman complained of recurrent frontal headaches of two years' duration. We attempted to clean up her chronic sinus infection with Proetz displacement and irrigations and autogenous vaccine. However, sinus x-rays with iodized oil studies revealed irreversible changes present, and not until the Caldwell-Luc surgery was done did she finally realize lasting relief. She has done extremely well since then for a period of two and a half years.

CASE 32.—A 40-year-old white man was having continual postnasal drainage year round, with recurrent pain over the right antrum of seven years' duration. Examination revealed a chronic maxillary sinusitis localized to the right antrum. He has been asymptomatic one and a half years postoperatively.

CASE 33.—A 56-year-old white man was treated for the past 10 years by physicians throughout the area for recurrent nasal polyposis, maxillary sinusitis, and a perennial type of nasal congestion. At no time had anyone investigated his allergic state. Initial examination here revealed the right antrum to be black to transillumination. There was a chronic tonsillitis and an allergic rhinitis. He had complete skin tests and was given autogenous vaccine and dietary restrictions and local and medical treatment of the sinuses. When the allergic state was under control, approximately seven months after initial examination, a Caldwell-Luc operation was done, revealing a large amount of chronic inflammatory and polypoid tissue, which was confirmed by the pathological examination. He has done very well for the two years postoperatively, and does not require vaccine desensitization now, as he has remained asymptomatic.

Summary

This report includes 33 cases of maxillary sinus disease that eventually had Caldwell-Luc surgery with the nasoantral window and mucosal flap over the exposed bone. All have been followed until clinically well, and the average postoperative period is 24 months. Cases cured medically or with less extensive surgical procedure, such as antrum windows, are not included.

This report includes 25 cases in which the antrum contained a markedly hyperplastic membrane in the form of a chronically inflamed membrane with polypoid formation, polyps and/or cysts; 7 cases of dental origin, 3 of these complicated by oroantral fistula and 2 by dentigerous cysts; and 1 case of anaplastic carcinoma, Grade 3.

The recognition of the role of allergy and its treatment; more effective and curative treatments known now for acute sinusitis; the more widespread use of sinus x-rays with contrast media to study the sinus not only from the standpoint of its initial appearance but, just as important, to evaluate its physiological function; the correction of obstruction to paranasal sinus ventilation; the treatment of systemic diseases and altered metabolic function—when all of these factors are investigated in each case, the problem of whether or not a patient requires maxillary sinus surgery, and which type, is greatly simplified.

We feel very strongly, along with Boies [1] and others, that chronic suppuration confined to the maxillary sinus is curable.

Eye and Ear Hospital.

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Audiology Section

JOSEPH SATALOFF, ASSOCIATE EDITOR

Frequency and Amplitude Modulation Audiometry

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As a member of a committee of the State of South Australia to discover cases of hearing loss in children up to age 16 in the State, I visited the audiology clinic of Professor Henk C. Huizing in The Netherlands. His method of testing babies and young infants was so impressive and simple that a similar apparatus was constructed for the Deafness Guidance Clinic in Adelaide by the sound engineers of Philips Electrical Industries. It is called an Audio-Frequency Wobbulator.

This instrument differs from a pure-tone audiometer in that the sound emitted has not a set frequency but, by frequency modulation, "warbles" to and fro above and below the chosen frequency. In addition the rate of modulation can be varied. By combining these two methods of varying the sound a very great variety of "warbles" can be produced. The range of the instrument coincides with that of the conventional pure-tone audiometer and the frequency-control dial is calibrated in the same way—"500," "1000," "2000," etc. When the dial is set at any frequency, the figure shown on the dial is that about which the modulation occurs. At each frequency the intensity can be varied smoothly from 0 to 100 db., and the intensity control dial is calibrated in 5 db. steps, as is usual. An interrupter switch has been included and rests in the "off" position. Sound is emitted only when the switch is depressed to the "on" position.

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In more technical language this apparatus consists mainly of three basic oscillators, two of which are series-tuned, one at a fixed frequency, the other variable. The fixed frequency oscillator is frequency modulated by an R. C. variable frequency oscillator ranging from 1 to 100 cps, and is controlled by a three-gang potentiometer. It is a series-tuned Colpitz oscillator operating in the ultrasonic region, is completely shielded, and is reactance modulated by the 1-100 cycles signal. The frequency range is then varied by the potentiometer, which gives modulation width and controls the output signal plus or minus 0-100 cycles, thus creating the characteristic warbling note.

The frequency range is controlled by a similar type oscillator, also completely shielded, and the frequency variation is caused by introducing a variable D C volt-

Fig. 1.—General view of the set-up. (1) Patient's chair with (2) two attached speakers and (3) detachable tray for play audiometry. (4) Audiometer. (5) Wobbulator. (6) Amplifier. (7) Portable Speakers. (Kindergarten table not shown)

Fig. 2.—Close-up view of Wobbulator and amplifier. Wobbulator: (1) Band width control. (2) Intensity control. (3) Modulation frequency control. (4) Frequency control. (5) Interrupter switch. Amplifier: (1) Main switch. (2) Select audiometer/Wobbulator. (3) Select left/right chair speaker. (4) Select portable/chair speakers. (5) Select left/right portable speaker.

age, thereby changing the frequency as much as 10,000 cycles. This voltage is controlled by a frequency dial and is calibrated from 100 to 8500 cycles. Both oscillator outputs are fed to a mixer tube and its output passed through a low-pass filter to eliminate the fundamental frequency of either oscillator. This signal is then taken to a calibrated attentuator via a switch which completely shorts out the grid of the amplifier, so that no signal is emitted until a switch is depressed at the operator's discretion. A conventional type power supply system is used.

The Wobbulator is approximately the same size as a conventional audiometer, and stands on a table in a sound-proofed room alongside an Amplivox Model 61 audiometer. Its output passes to the patient through loud speakers. There are two sets of speakers, one set portable and the other set fixed to the arms of a chair on which the patient may sit. The output of the pure-tone audiometer can also be directed through the amplifier to the portable and fixed speakers, as well as directly to the earphones without amplification. The amplification is such that the intensity of the sound delivered from the fixed speakers to a patient seated on the chair is practically equal to that at which the sound would be delivered to his ears if he were wearing headphones and amplification were not used.

The testing which can be carried out with the instrument may be divided into three groups, graded approximately by the child's age and mental development, thus:

1. From 6 months to about 21 months.
2. From 21 months to about 33 months.
3. Older children.

1. In the youngest age group it is best for the child's mother to sit on a chair and hold the child on her lap with its ears exposed as freely as possible in an attempt to prevent masking by the mother's clothes

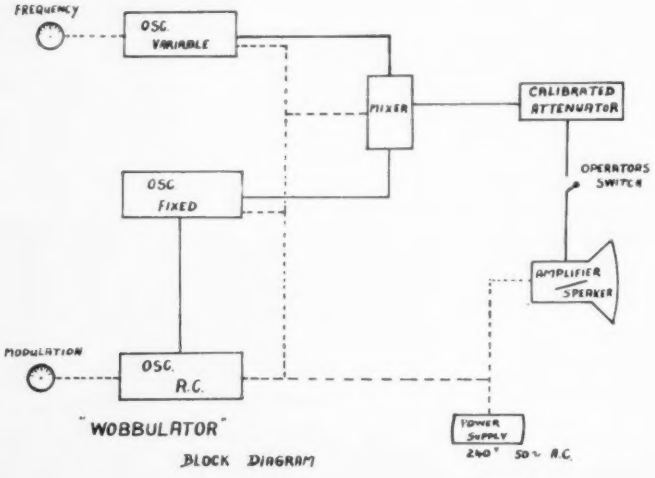

Fig. 3.—Block diagram showing component parts and connections of the Wobbulator.

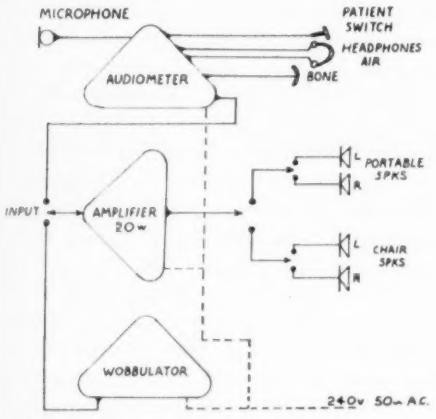

Fig. 4.—Diagram showing connections between Wobbulator, audiometer, amplifier, and the two sets of speakers.

or body. The portable speakers are placed conveniently close and to left and right of the child. The warbling sound is introduced on one speaker at a frequency of 1000 cps and an intensity of 20 db.; the band width and the frequency of warble are varied over their various ranges, the sound being interrupted between the different settings. If no reaction is obtained, the procedure is repeated at an intensity of 40 db., and so on up to an intensity of 100 db. in 20 db. steps. This 20 db. step has been chosen purely as a means of shortening the time of testing. It may be possible to test one ear over the whole range without interruption, but more frequently it will be necessary or convenient to change from one ear to the other because of variation in the child's position or its restlessness and so forth. Several sittings may be necessary before an approximate picture of the child's hearing capacity can be obtained. It is necessary for an observer to watch the child closely during the testing for eye turning or head turning or a combination of the two, which are the usual reactions to hearing the sound. It may be difficult to distinguish between head turning as a reaction and that due to restlessness. Repeated tests and consistent responses are the only answer to this.

By using pure-tone sounds in the speakers instead of the warbling tone it is easily demonstrated that a child will respond to a warbling tone of much less intensity than to a pure tone of the same frequency.

2. The second group (and its age limits very widely) consists of those children who will sit at a kindergarten table and play with toys, blocks, and so on.

For the test the child sits at a kindergarten table with its mother or an assistant near by to assist in maintaining its interest in the toys and blocks. If the child will play by itself, the mother or assistant keeps well in the background. The portable speakers are placed to left and right of the child, fairly close but not so close as to act as objects of more than passing interest in themselves. As the child plays at the table, the warbling sound is introduced as described above for the first group. Reception of the sound is usually indicated by turning the head towards the side from which the sound comes. This may be accompanied by alteration of posture, in some cases amounting almost to a startle reaction, the child suddenly sitting upright in the chair with head and eyes turned toward the speaker.

It is possible with this set-up to obtain a picture of the child's hearing, albeit only an approximation. It is also possible to make a beginning at "play" audiometry, and again the difference in response to warbling tones and to pure tones is easily demonstrated.

3. The third group has a lower age limit, which varies greatly with the development and intelligence of the children tested and will tend to become lower as the experience of the testing team becomes greater.

The younger children are introduced to the warble while playing at the kindergarten table and are fairly quickly led on to play audiometry. As their familiarity with the test and their self-assurance increase, they are transferred to the testing chair. Here warble-tone audiograms are

prepared by means of play audiometry using warble introduced through the speakers at fixed distances from the child's head. Pure tones are then substituted for the warble, and pure-tone audiograms are prepared in the same way. Finally the child is introduced to the headphones. With the knowledge of sound and testing technique obtained from the free field testing, the child will tolerate the headphones more easily and at a younger age, so that it is possible to obtain pure-tone audiograms (in the ordinary sense of the term) at a much younger age than has been the case hitherto. To date the youngest child from whom we have been able to prepare a warble tone audiogram was just under 2 years. This knowledge of sound and earlier toleration of it should be of assistance in the earlier fitting of hearing aids, so helping in the earlier acquisition of language and speech.

There is still much to be learned about the use of this instrument to find its correct place in our armamentarium, but it gives rise to much interesting speculation, the proof of which must lie in careful analysis of many tests. In a city of somewhat more than 500,000 people considerable time must elapse before any worth-while statistics can be given. One most intriguing question is why does a child respond to a warbling tone at a lower intensity than to a pure tone of the same set frequency. If warble of a certain intensity stimulates the cochlea then pure tone of the same intensity should stimulate the cochlea. If this is so, and the auditory pathways are the same, then the difference in response must lie at or near cortical level. If this proves to be the case then we shall have to revise our ideas of threshold reception levels. It would be interesting to compare the threshold audiograms for warble and for pure tone in cases of peripheral deafness, central deafness, and cortical auditory disorders.

Dr. A. R. Southwood, Director General of Public Health, South Australia, gave permission for the publication of this report, and the Minister of Health, Sir Lyell McEwin, through his encouragement and assistance made possible the production and use of this instrument.

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The Use of Hearing Aids by Public School Children

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Children who do not talk by about 2 years of age frequently are suspected of hearing loss by parents and physicians, and with increasing frequency they find their way to audiological clinics. If deafness is confirmed, the parents are counseled regarding special education placement, and it may be assumed that most of these deaf children find their way to special schools. Thus, it is seldom that a profoundly hearing-handicapped child is found in the ordinary public school classroom, and children using hearing aids in the public schools have mild and moderate degrees of hypacusia.

Data on incidence of hearing loss among school children have accrued for a number of years. The average incidence is thought to be about 4% or 5%,[1,6] but there is a wide range reported. Some recent data are shown in Table 1. The Michigan and the Pennsylvania percentages are based in part on use of the Western Electric fading numbers test for mass screening. (Although not shown in Table 1, in Michigan about two-thirds of the children with losses had only unilateral involvement, and did not need acoustic rehabilitation.) Rochester, N. Y., used the Western Electric numbers test, a group pure-tone screening, and individual pure-tone screening at 15 db. Armstrong and Center Counties used individual pure-tone screening at 20 db. and 15 db. respectively. For Armstrong County, a single failure at any frequency from 250 to 8000 cps constituted a test failure; Center County required two frequency failures at 15 db. As these data indicate, the hearing-defective group in the schools is a relatively small portion of the total school population. However, because of the large school population the number of such children is considerable.

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TABLE 1.—*Results of Recent School Hearing Screening*

School Area and Source	Incidence Confirmed Hearing Loss, %
Michigan (Osborne, C.: personal communication, 1943–1950)	2.7
Pennsylvania-rural (Landis, J.: Tr. Am. Acad. Opth. 56:73–76, 1952)	3.8
Rochester, N. Y. (Yankower, A., et al: Am. J. Pub. Health 44:77–82, 1954)	4.9
Armstrong County, Pa. (Sommers, R.: Pennsylvania Speech Annual, 14:32–35, 1957)	2.8
Center County, Pa. (personal communication from supervisor, 1957)	2.4

The role of hearing aids in public school programs for hearing-defective children is a matter of interest to classroom teachers, speech and hearing therapists, and clinical audiologists. It is the intent of this paper to review some literature on the incidence of hearing aid use by school children and obtained changes in speech reception thresholds. In addition, data on hearing aid use in a school district in Pennsylvania will be presented.

Review of Previous Data

Guilder and Schall[3] found that four children representing a group of 43 with conductive loss obtained 20 to 25 db. gain in speech reception threshold, using hearing aids. Four children representing 19 with high-tone deafness obtained 15 to 20 db. gain.

Gates and Kushner[2] reported a follow-up study of 25 children continuing to use their hearing aids several years after the aids were first obtained. (Thirteen other children had discontinued the use of aids.) Some children used their aids throughout the day, while others used their aids part

time or only for special occasions. In general, greater degrees of hearing loss were associated with more extensive use of aids.

In 1948, Morley[4] reported a series of speech reception threshold tests on seven children 10 to 12 years of age. They recently had acquired hearing aids and were participating in a six weeks' summer speech, hearing, and remedial education program. At the beginning of the program, the mean speech reception threshold gain with hearing aids was 33.4 db. for spondee words and 39.7 db. for phonetically balanced words. Six months after completion of the summer program the mean gain was 42.0 db. for spondee words and 36.3 db. for phonetically balanced words.

In 1950 Gardner[1] prepared a comprehensive report covering the years 1947 and 1948 on hearing programs for school children. He found a ratio of 1 child in 2800 wearing an aid. On the assumption that a hearing loss of over 35 db. requires the use of an aid, he estimated that at least four times as many should be wearing them.

Siegenthaler and Gunn[5] investigated some factors associated with help obtained from individual hearing aids among 131 subjects ranging from 7 to 98 years of age. About one-third were school children. Among the subjects with conductive loss there was not a statistically significant correlation between per cent gain with an aid and age. (Per cent gain was unaided SRT minus aided SRT, divided by unaided SRT.) For subjects with perceptive hearing loss there was a negative correlation between age and per cent gain with aids ($r = -0.25$, significant at 0.05). The perceptively deafened had a mean per cent gain for speech reception threshold of 64.1%, the conductive deafened a mean per cent gain of 83.8%, and various types of mixed deafness subjects had mean per cent gains from 42.0% to 75.8%.

Silverman and Benson[6] prepared in graphic form what they were careful to call a "rough guess" of the proportions of hearing-handicapped persons of various ages who can obtain satisfactory results with hearing aids. They assumed that a hearing loss of at least 30 db. is required before an aid is useful, and that satisfactory use of an aid is obtained if it makes possible adequate communication in social situations. Among children who have sufficient hearing loss to require the use of an aid, the percentage of satisfactory users was believed to increase from about 15% at about age 6, to about 90% at age 17.

Center County Data

The Commonwealth of Pennsylvania operates a number of centers to which public school children found to have reductions in hearing acuity are sent for audiological services. One of these centers, located at The Pennsylvania State University, serves the central region of Pennsylvania including Center County. Center County is largely a rural area; its largest population center is the university town of State College (nonuniversity population about 10,000). The school population of the county during the 1957-1958 school year was 6536 in Grades 1-6 and 4693 in Grades 7-12.

The clinical files of the 131 Center County school children seen at the center to date were examined. (This number is not intended to indicate the total number of children in the county having hearing loss, but the speech and hearing supervisor for the county believes all children having handicapping losses have been to the center.) Although many of the children were seen for more than one clinical appointment, only the results of a child's initial appointment were considered to obtain an estimate of the hearing condition of the children without therapeutic results reflected in the findings. (However, those children who were seen for more than one appointment and for whom hearing aids were finally recommended were tabulated with those for whom hearing aids were recommended on the first visit.)

Of the 131 Center County children seen at the center (1.1% of the total school population in Grades 1-12), 100 were in Grades 1-6 and 31 were in Grades 7-10. Of the elementary grade children, 56 had normal hearing acuity; 29 had conductive losses; 11 had perceptive losses; 3 had mixed type losses, and 1 malingered. Among the secondary grade children, 15 had normal hearing acuity; 8 had conductive losses; 5 had perceptive losses; 2 had mixed losses, and 1 malingered.* The median better ear averages for frequencies 500, 1000, and 2000 cps among children with hearing losses were 27 db. for the lower grades and 36 db. for the upper grades. Median speech reception thresholds were 27 db. and 35 db. for the lower and upper grades respectively, and median intelligibility for phonetically balanced word lists presented 40 to 50 db. above normal threshold was 75.5% for the lower and 76.0% for the upper grades.

Table 2 indicates disposition of the 60 children with hearing loss among the 131 examined in the clinic. The most frequent recommendation for the total group was otological attention, usually for otitis media or other conductive deafness problems. This recommendation was made for 43% of the elementary grade children. Also, among the elementary children 18 (41%) had losses for which aids were not needed or for which only classroom adjustment was recommended. Among the secondary level children there were three (19%) with losses of this type. These children had adequate communication skills; they were making satisfactory adjustments in school and home, or hearing aids were not indicated because of insufficient help obtained from aids. Among all children with losses not requiring the use of aids or needing classroom adjustment, the range of average pure-tone acuity was from 16 to 40 db.; the median was 22.5 db.

By summing the categories "child or family rejected aid," "desk aid for school," and "individual aid," the total number of children needing acoustic amplification was obtained. Among all children seen in the clinic, 15 (25%) were judged to need acoustic amplification (14% among Grades 1-6, and 56% among Grades 7-12). Thus, about 1 child in 1088 among all elementary grade children enrolled in the public schools of Center County needs acoustic amplification; 1 child in 521 among all secondary grade children needs acoustic amplification, and among the total school population, about 1 child in 748 needs acoustic amplification help.

Table 3 shows further details regarding the 15 children for whom amplification recommendations were made. Ten had perceptive losses; four had conductive losses, and one had a mixed loss. The 22 db. median speech reception threshold gain with the use of aids by this group is some-

* Some children with normal acuity (better ear average for frequencies 500-2000 cps of at least 15 db. H. L.) were found by otological examination to have middle-ear disease. However, if the average pure-tone acuity was within 15 db., the child was classified as "normal."

TABLE 2.—*Disposition of Sixty Children with Hearing Loss from Files of Hearing Center* *

Disposition	Grades 1-6 (N 44)	Grades 7-12 (N 16)	Grades 1-12 (N 60)
Advised otological attention	19	3	22
Child or family rejected aid	1	1	2
Aid not needed	14	2	16
Malingering	1	1	2
Class room adjustment	4	1	5
Desk aid for school	0	2	2
Individual aid	5	6	11

Note: About 1 child in 1088 among the elementary grades needs acoustic amplification.
About 1 child in 521 among the secondary grades needs acoustic amplification.
About 1 child in 748 among the total school enrollment for grades 1-12 needs acoustic amplification.

* Total school population served is 11,229.

TABLE 3.—*Hearing Acuity and Benefit from Aids for Fifteen Children Recommended to Obtain Acoustic Help* *

	No.	Range	Median
PT average	15	20-68 db.	37 db.
Unaided SRT	14	14-70 db.	37 db.
Db. gain in SRT with aid	9	10-46 db.	22 db.
Unaided % intell. at 40 db.	12	24%-88%	47%
Gain in % intell. with aid, at 40 db.	3	16%-60%	32%

* Four children had conductive deafness; one had mixed deafness, and ten had perceptive deafness.

TABLE 4.—*Disposition of 274 Children with Hearing Loss Among School Population of 11,229* *

Disposition	No. of Children †
Unilateral loss	27
Watch cases ‡	203
Mild losses §	35
Wearing aid part time §	2
Wearing aid always §	7

* Courtesy Miss Maude Brungard, supervisor speech and hearing, Center Co., Pa.
† From a total school population of 11,229.
‡ Slight losses at some frequencies; if develop further will be referred for more services.
§ Have or are receiving acoustic or speech reading training.

what less than the average gain of as high as 43 db. found by Morley,[4] but it is a few decibels more than the 15 to 20 db. gain for perceptively deafened patients reported by Guilder and Schall.[3] The 22 db. gain is an average of 59.4% improvement in threshold and is close to the 64.1% average gain for perceptive deafened patients found by Siegenthaler and Gunn.[5] Unfortunately, the average per cent gain in speech intelligibility in Table 3 is based on so few cases that it is of little value.

The supervisor of speech and hearing for Center County provided the information in Table 4 regarding the handling of hearing loss children in the schools in part as a result of clinical evaluations and recommendations. Of the 274 children known to have hearing losses, 230 (84%) have nonhandicapping losses (sum of the "unilateral loss" and "watch case" groups). The 9 children wearing aids either full time or part time produce a ratio of 1 child in 1248 in the Center County schools using acoustic amplification. This ratio is somewhat different from the 1 child in 748 needing acoustic amplification according to the clinical records. The difference is a total of six children in the county who should be receiving the benefits of acoustic amplification but who are not doing so. Of the six children not using aids, two have rejected them and the other four apparently are having financial and similar difficulties in acquiring them.

Summary and Conclusion

The average amount of acoustic gain for speech reception threshold obtained by school children wearing hearing aids has been found to be from 15 to over 40 db. by various investigators. Among the Center County children for whom aids were indicated, an average speech threshold gain of 22 db. was found. This average gain is about a 60% reduction in hearing loss as the result of wearing hearing aids.

Among the school children of a predominantly rural county of central Pennsylvania, about 1 elementary grade child in 1100 needs acoustic amplification, and about 1 secondary grade child in 500 needs acoustic amplification. Among the total school population in Grades 1-12 about 1 child in 750 needs acoustic amplification. This last ratio is close to the 1 child in 700 among the general school population needing a hearing aid found by Gardner.[1] However, in practice at the present time only 1 child in about 1250 is using acoustic amplification in the school area studied.

The difference between proportion of children recommended to wear aids and number of children wearing aids in the Center County schools demonstrates that even in a school area where the clinical audiologist, the otologist, and the school speech and hearing supervisor work in close coordination and with sincere effort to carry out the appropriate hearing aid recommendations, there remain difficulties in providing every child who needs acoustic help with that kind of assistance.

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Correlation of Filtered, Band-Limited White Noise and the Speech Reception Threshold

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Although of varied form and in wide use, speech reception tests have their drawbacks. The following research was directed toward investigating and eliminating some of these negative aspects.

Speech reception testing evaluates the over-all hearing function, not just the sensory capacity of the ear to perceive sounds of various frequencies and intensities. Therefore, such cortical processes as synthesis, analysis, discrimination, cluster (guessing at the meaning from the relation of the various parts), memory, fatigue, effort, and language ability affect the outcome of any speech test in a manner which is nonpredictable today. Also, intertest validity suffers from factors governed by regional dialect, voice quality differences, articulation differences, etc., on the part of the tester.

Speech reception test elements are, by nature, heterogeneous. This means that no two words are exactly alike, and, as a result, we must not expect the listener to just hear all words at the same intensity. In a test of threshold, it would be more desirable to say that a listener heard the stimulus at a given intensity, rather than obtain a statistical average of a number of varied acoustical stimuli. Hirsh [8] says, "Ideally . . . the most sensitive gain function would be that of lists of words that were so homogeneous that all of the words would become just intelligible at the same intensity." (Later you will see that white noise fulfills this requirement.)

It has been shown by Egan [4] that articulation scores obtained with inexperienced listeners show improvement with practice. The stability of the speech test results is endangered if in eight successive days an inexperienced person can improve by 18 db. for monosyllabic words. Learning, then, is a contaminating factor which must be considered when we use speech as the auditory stimulus.

Apart from the character of the word lists themselves, there is the problem of time in test administration. Silverman [9] reported that six hours was required to complete the articulation score versus intensity level above threshold studies, though it was believed that this time could be reduced considerably. In a typical clinical situation, scores relating to speech reception threshold and discrimination loss might be obtained in one-half hour to 45 minutes. A test which would save time, yet produce the needed information, would be highly desirable.

Suggested Substitutes

Substitutes for the speech reception test have been advanced by several researchers. Carhart,[2] while not suggesting specifically the substitution of an evaluation of the pure-tone audiogram for the speech reception tests, implied that an estimate of the threshold of hearing could be obtained by such means. Positive correlations in the order of 0.71 for unselected audiograms were found between speech reception thresholds and the average values in the audiograms for 512-2048 cps. Thurlow et al.[10] found similar relationships. Falconer and Davis [5] calculated the relationships between the threshold of intelligibility for connected discourse (TICD) and Auditory Test No. 9. They found that these tests

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compared favorably with one another in both dispersion and reliability.

Hayes and Butler [7] suggested still another substitute method. They stated that since the important frequencies inherent in speech sounds range approximately from 500 to 2500 cps, a click stimulus may be transmitted through a filter so that only the frequencies within the range would be delivered to the earphone.* Thresholds for spondee words correlated very highly with these clicks (0.97).

An acoustic stimulus which is totally redundant, and which would carry the same information from person to person, should lead to more reliable threshold scores. This stimulus should be broad-band in nature and activate many hair cells, as speech does. Such a stimulus would be similar to speech in this respect, and we may infer that a listener would respond to this stimulus in much the same manner as he would respond to speech, except that his higher cognitive processes would not be involved save in recognizing the sound as the test stimulus. A test using this stimulus would examine an individual's ability to hear a complex sound at a given intensity level, and this level should be related to his ability to hear speech. White noise was used as such an acoustic stimulus for the following reasons:

1. White noise is a signal which contains every frequency in the audible spectrum.

2. White noise is an acoustic signal which is similar to speech in that its energy spreads over the audible spectrum in a transient manner.

3. White noise can be repeated identically, and its gain function resembles that of an ideally homogeneous word list.

4. White noise can be generated easily electronically.

Method and Material

The immediate aim of this experiment was to correlate speech reception thresholds with thresholds for each of five noises in a group of normal and abnormal ears. The study was carried out to determine whether it is possible to predict the speech reception threshold of an individual from his threshold for one or more of the noises.

The speech reception threshold was measured with a magnetically recorded version of Auditory Test No. 9. With constant level monitoring, the experimenter recorded 20 spondee word lists with a high-quality condenser microphone on an Apex tape recorder. The words were played back on a Magnecord tape recorder, through a flat amplifying system and into a PDR 10 earphone. Acoustic output of the earphone varied less than ±1 db. from 100-2000 cycles and ±8 db. from 2000-8000 cycles (Fig. 3).

The noise stimulus was produced from a white noise generator and fed into one of five different filters. Filter A (broad-band white noise) provided the reference level for all the other filters. The other filters produced only slight insertion losses at their points of maximum transmission (Fig. 10).

Filter A: Broad, limited only by the response of the earphone and the amplifier system.

Filter B: A slow-sloping, high-pass filter.

Filter C: A band-pass filter between 1000-4000 cycles.

Filter D: This filter was designed after the Dunn and White [8] curve, which is the average long-term spectrum measured for six men and five women.

Filter E: Similar to Filter D but shifted upward in frequency.

The particular shapes of the filter curves were chosen with respect to the possibility of their correlating well with the SRT. Figure 4 shows the response curves of the filters when the output from the earphone was measured in a 6 cc. coupler with a 640 AA condenser microphone and associated vacuum tube voltmeter. Figure 1 shows a block diagram of the over-all system. The noise generator's response was flat within ±1 db. from 50 to 10,000 cycles. The over-all system had a high signal-to-noise ratio and a person with above-average hearing sensitivity could hear no amplifier hiss or hum when he was tested at his threshold for speech or noise. Oscilloscopic examination of the signals through the earphone showed no distor-

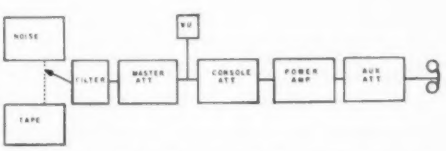

Fig. 1.—A block diagram of the over-all system.

*I started my own experiment unaware of the work of Hayes and Butler. Aside from academic considerations, my experiment using white noise shows certain advantages over filtered clicks. These will be developed later.

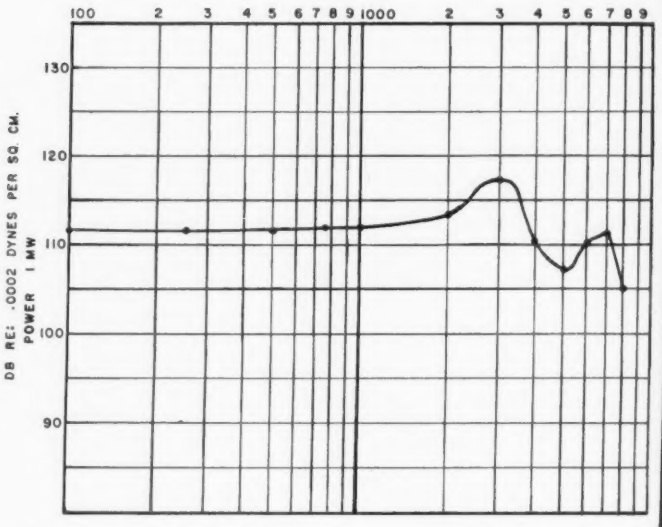

Fig. 2.—Sound pressure response curve of the PDR 10 earphone when 0.1 volt is inserted at 1000 cycles. Note: A peak at 1800 cycles is absent because no measurement was taken at that frequency.

tion due to overloading of speech or white noise at maximum intensities.

The earphone employed was a PDR 10. Response curves were obtained before and after the experiment to be certain that no changes took place in the earphone during the tests. The sound pressures from the earphone when 0.1 volt was inserted at 1000 cycles are indicated in Figure 2.

Limiting Factors.—Wever and Lawrence [11] point out that physiological noise of the ear, caused by random variations in tensions of the mechanical parts, and especially of the tympanic muscles; the presence of metabolic and other chemical activities in the cells, and the noise conveyed to the ear from the flow of blood and from other bodily activities may cause normal thresholds to vary.

Brogden and Miller [1] have shown that the cavity under the earphone cushion may accentuate enough physiological noise in the ear canal to offset the favorable attenuation effects of the cushion on room noise. In my experiment, a sound-treated room was employed, and care was taken to choose an earphone cushion of optimum shape (flat and shallow).

The limiting factor, therefore, in our experiment, in testing normal ears, was physiological noise generated under the earphones. We can anticipate confusion in some normal-hearing individuals who, when listening for the noise stimulus, will respond to physiological noise instead. This confusion might occur if a person with exceptionally acute or sensitive hearing is unable to differentiate the character of the noise stimulus from the physiological noise. Actually this happened very infrequently during the experiment.

Subjects.—There were 24 subjects who supplied 48 ears. Of this group, there were 26 normal ears, 16 ears with perceptive loss, 2 ears with conductive loss, and 4 ears with mixed loss. They were all English-speaking people living in Michigan, ranging in age from 20 to 70 years.

Results

A high correlation between the noise stimulus and the SRT will suggest that it is worth while to predict the SRT from any

TABLE 1.—*Correlation Coefficients Between Each of the Noise Stimuli and the SRT*

Noise Stimuli	Correlation Coefficient
A	0.981
B	0.918
C	0.948
D	0.988
E	0.997

TABLE 2.—*Standard Errors of Estimate of the SRT as Predicted from the Noise Threshold*

Noise Stimuli	Standard Error of Estimate, Db.
A	6.057
B	8.688
C	6.977
D	4.808
E	2.909

of the filters. Table 1 shows the correlation coefficients for each of the noise stimuli and the SRT.

The high correlation coefficients in Table 1 suggest good predictability of the SRT from any of the noise stimuli. An examination of Table 2 shows that filters A, D, and E have relatively small standard errors of estimate. This, coupled with their high correlations, indicates that these noises would be most satisfactory for prediction of the SRT.

Table 2 shows the standard errors of estimate of the SRT as predicted from noise thresholds.

The standard error of estimate tells us the precision of our predictions. Ninety-five per cent of all cases will be predicted correctly with ± 2 standard errors of estimate. We may, therefore, expect the prediction using Filter A to lie within ± 12 db. of the actual SRT; Filter D to lie within ± 10 db. of the SRT, and Filter E to lie within ± 6 db. of the SRT. The correctness of prediction may also be seen in the scatter diagrams in Figures 5 through 9, in which the broken lines represent the predicting equations.

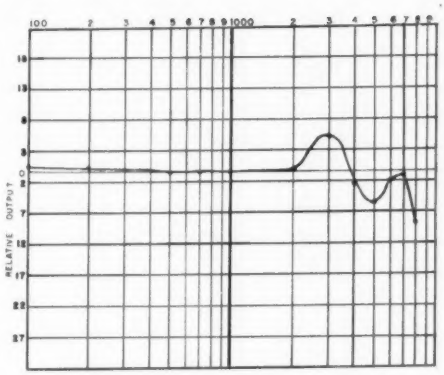

Fig. 3.—Response curve of the recorded tones on the tape through the amplifying system, and through the earphone.

The regression functions of the various noise stimuli and the SRT, as shown by the scatter diagrams, demonstrate that these variables are related linearly. The regression equations listed below give the constant difference (k) from the computed

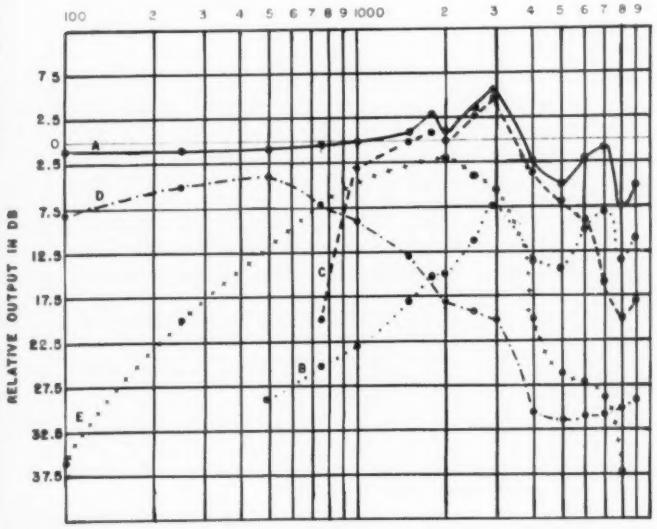

Fig. 4.—Shows the response curves of the filters and earphones in series.

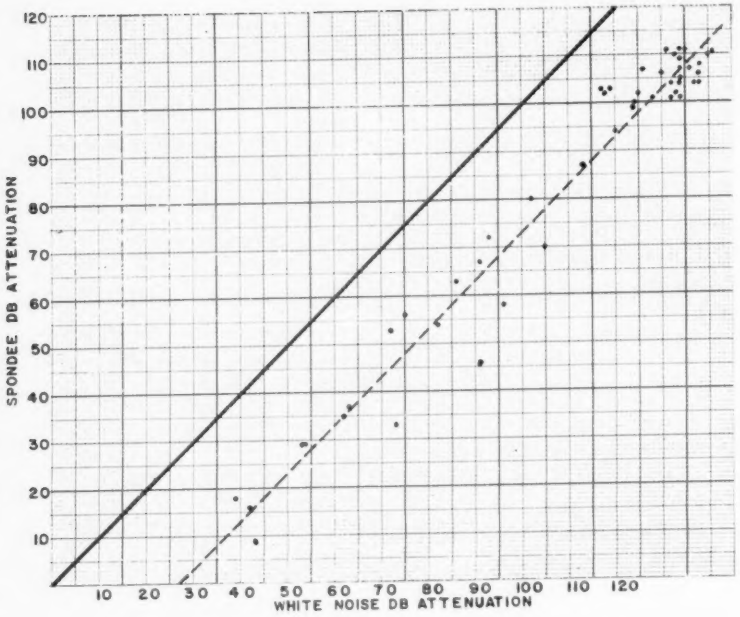

Fig. 5.—Scatter diagram of SRT with noise stimulus A.

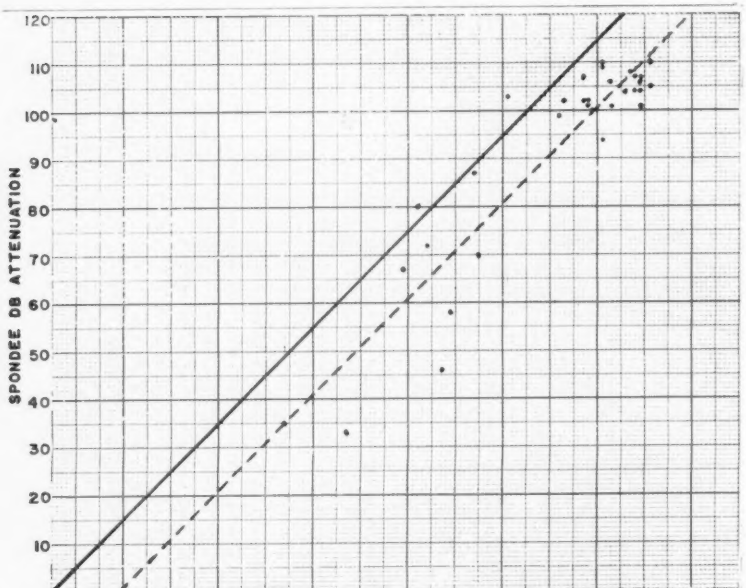

Fig. 6.—Scatter diagram of SRT with noise stimulus B.

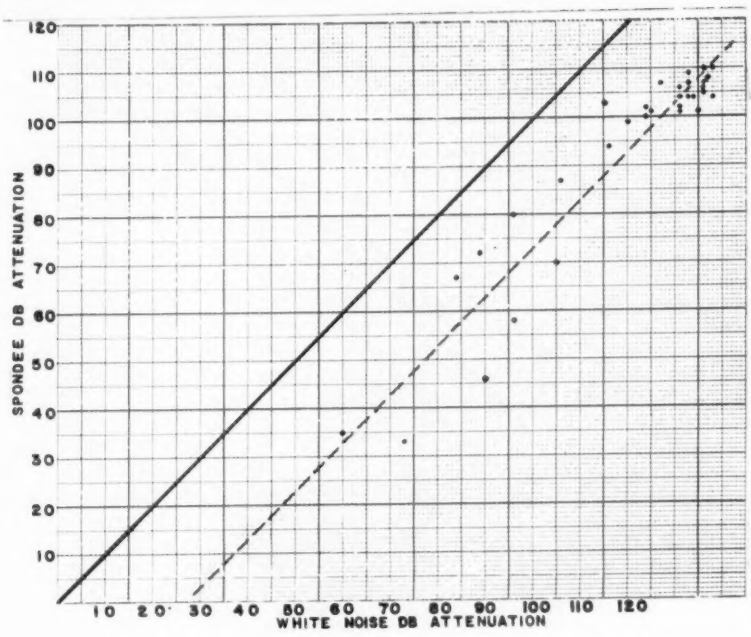

Fig. 7.—Scatter diagram of SRT with noise stimulus C.

values of the means of the x's (SRT scores in attenuator readings), the means of the y's (filter scores in attenuator readings), and the computed slope of their linear relationship.

(A) $x = 0.989y_1 - 25.50$
(B) $x = 0.975y_2 - 11.55$
(C) $x = 0.990y_3 - 25.64$
(D) $x = 1.014y_4 - 16.47$
(E) $x = 0.0975y_5 - 19.40$

It will help to simplify our original regression formulas if we examine the standard errors of estimate of the slopes of the five equations. Table 3 shows the standard errors of estimate for the slopes of the regression lines.

With standard errors of estimate of the slopes of this size, it is obvious that the slopes are all close enough to 1 to allow us to simplify by letting $B=1$. Rewriting the regression equations with $b=1$, we have the following:

(A) $x = y_1 - 26.71$
(B) $x = y_2 - 14.21$
(C) $x = y_3 - 26.83$
(D) $x = y_4 - 15.11$
(E) $x = y_5 - 21.64$

Table 4 shows the means for the SRT in normals, the mean thresholds for each of the noise stimuli, and the standard deviation of each noise. The constant difference between the means for normals in the SRT, and the means for normals in all the filters is also indicated.

TABLE 3.—*Standard Errors of Estimate for the Slopes of the Regression Lines for x and y*

Noise Stimuli	Standard Error of Estimate
A	0.028
B	0.074
C	0.058
D	0.023
E	0.017

TABLE 4.—*Means, Standard Deviations, and Constant Differences for the SRT and Filters in Normals*

	N	Mean Threshold Db. Attentuation	Standard Deviation Db.	Constant Difference Db. Attentuation
SRT	26	105.6	0.7	-0-
A	26	132.2	1.2	26.6
B	20	113.9	5.4	8.3
C	20	132.5	1.0	23.9
D	26	118.9	0.9	13.3
E	8	129.9	2.1	24.3

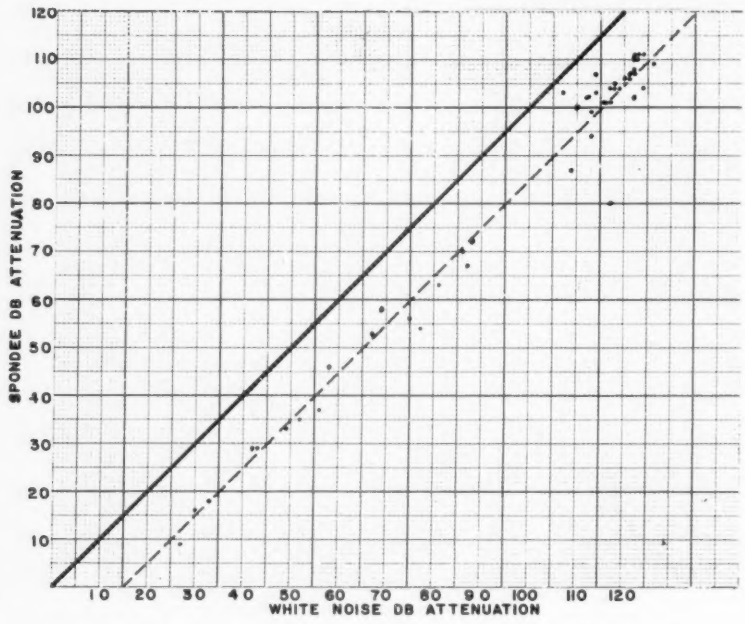

Fig. 8.—Scatter diagram of SRT with noise stimulus D.

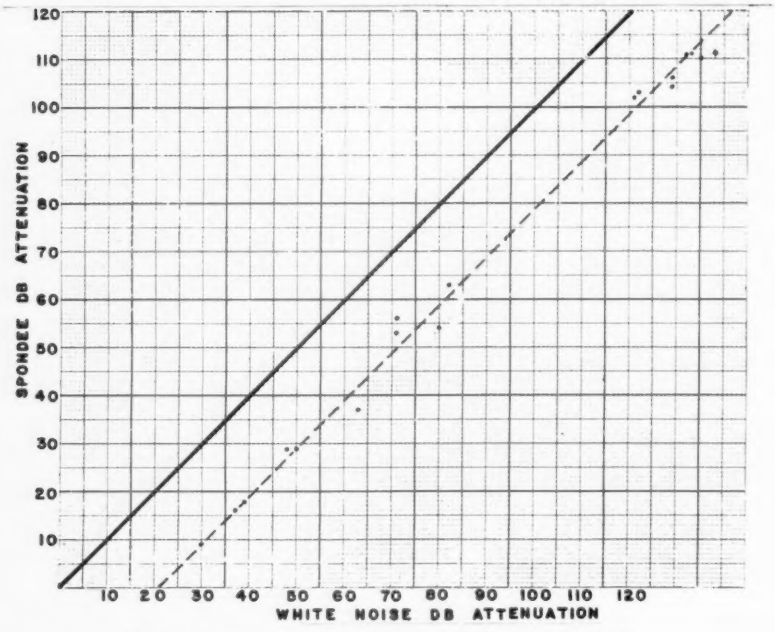

Fig. 9.—Scatter diagram of SRT with noise stimulus E.

The constant differences indicated in Table 4 shows that they do not differ greatly from the constant differences derived from the simplified regression equations. We may then infer that the mean difference derived from the normal group is almost the same as the mean difference derived from the total group. Filters A, D, and E show smaller differences between constants derived from normals and constants obtained from the total group. The largest difference (2.6 db.) occurs in Filter E.

It follows, then, that by subtracting the means of the normal group for the SRT from any one of the means of the superior three filters, a constant is obtained which is almost identical with the constant difference in the simplified regression equations. In a clinical situation, the constant difference between the SRT and the noise stimulus may be derived by testing a group of normals only and subtracting the threshold readings of the SRT from the threshold readings of the noise stimulus. The constant, thus derived, may be used in the future to predict the SRT by substracting the constant difference from the clinically obtained noise threshold. The attenuator readings may, of course, be converted to sound pressure levels. If it is desired only to state the hearing loss for speech re normal or sensation level, it is permissible to obtain an average normal noise threshold and predict that the hearing loss for speech will be equal to the threshold for the noise stimulus.

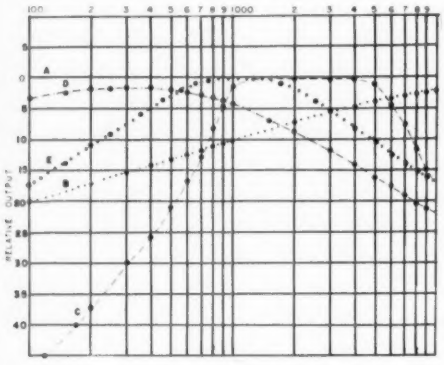

Fig. 10.—Shows the response curves of the filters alone as measured with a vacuum tube voltmeter.

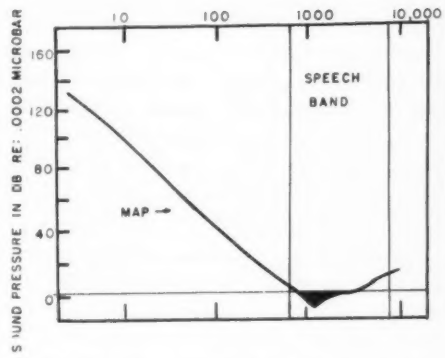

Fig. 11.—Shows normal threshold curve intersected by band of white noise.

It is apparent that all the noises have a high correlation with the SRT; some more so than others. The standard errors of estimate demonstrate that we can predict the SRT with comparative accuracy. Filters A, D, and E show superior correlations as well as smaller standard errors of estimate. The precision of prediction with the use of Filters A, D, and E suggest that any one of them would serve better in a clinical situation than either B or C.

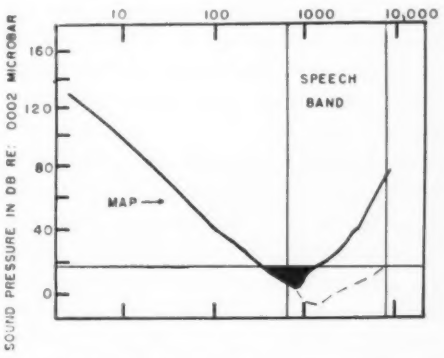

Fig. 12.—Shows high-tone loss curve intersected by band of white noise.

Summary

Transient, complex acoustic stimuli may be used as an effective substitute for certain kinds of speech stimuli in threshold tests. The high correlations evidenced in this study, lead us to conclude that noise may now be substituted for Auditory Test No. 9 in order to determine an SRT.

An interesting extension of this experiment presents itself when we consider the use of white noise thresholds as a clinical tool. Let us construct a threshold curve similar to the Minimum Audible Pressure curves in Figures 11 and 12. A line representing a white noise threshold is drawn intersecting the most sensitive region of the curve and overlapping a critical band width. In a normal ear this would occur at about 1000 cycles, and the numerical value of this line in terms of sound pressure would be the prediction of the SRT.

This procedure should also support Fletcher's[6] formula for the prediction of the SRT, since the two best frequencies from 500 to 2000 cycles would be crossed first by the white noise curve. It is perhaps for this very reason that we have obtained such very high correlations between speech and noise. Evidently the spread of acoustical energy along the basilar membrane is accomplished in a similar manner by both speech and noise, in effect averaging the different frequency contributions to the signal. The continuous quality of complex sounds in contrast to the discrete quality of pure tones would lead one to expect these relationships even before experimentation.

It was suggested above that a saving in time might accrue from the use of this test. The average time required to administer the Spondee Word Test was approximately six minutes. The average time required to administer any one of the white noise tests was 1.5 minutes. In the author's opinion, this represents an appreciable savings in time. Over an extended period of time these minutes might be reflected in greater efficiency in a typical clinical situation.

If we were to choose one of the three best filters for a clinical test, Filter A (wide broad band) would be the most suitable. An electronic system using this noise would be simpler to construct than any other filter arrangement; it is more readily available; and the correlation and standard estimate of error are almost as good as the best. The convenience which this test might offer to a clinic is apparent.

Conclusions

1. The hypothesis that it is possible to predict the SRT by use of a threshold for noise is established.

2. It is possible to predict the speech reception threshold of an individual from a white noise threshold with precision entirely adequate for clinical purposes.

3. Substituting the white noise test for the SRT permits us to avoid such problems as language difficulties, learning, and excessive expenditures of time which testing with speech may involve.

4. A broad band noise, such as is available in many hearing clinics, is a suitable stimulus for this purpose.

5. The high correlation between the SRT and the white noise threshold is related to Fletcher's formula of the best two average between 500-2000 cycles.

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Case Reports

Sarcoidosis of the Larynx

WILLIAM M. TRIBLE, M.D., Washington, D. C.

Sarcoidosis is a not uncommon systemic disease found chiefly in the southeastern United States. Only rarely is the otolaryngologist confronted with its complications. The case reported here is that of a patient who had had two tracheotomies performed to relieve obstructive dyspnea from this condition; her course was then apparently favorably influenced by prednisone, which allowed her decannulation.

Report of a Case

A 32-year-old Negro woman was first seen at the Episcopal Eye, Ear, and Throat Hospital on Oct. 2, 1950, complaining of a lump in her left eyelid of six months' duration. At this time she was seen to have two verrucous lesions of the left inner canthus, as well as a deeper mass in the region of the left lacrimal gland. Both verrucae were removed, and the lacrimal gland was subjected to biopsy. All three sections were considered by the pathologist to be typical of Boeck's sarcoid. She was referred to the ear, nose, and throat clinic for minimal hoarseness, and a small polypoid growth was discovered on the superior surface of the left true cord anteriorly. This was removed and reported as "tuberculosis versus sarcoidosis—sections show rounded groups of epithelial cells, fibrosis, and in one section there is an area of necrosis." Chest and hand x-rays were negative. She received no specific therapy, and was next seen in March, 1954, complaining of hoarseness for one year and the appearance of new lesions on her face, beginning at the right ala nasi. A biopsy from the forehead was reported as "Boeck's sarcoid," and the patient was referred to the Dermatology Clinic at Freedmen's Hospital. She received several medications but no steroid therapy. The skin lesions inconsistently improved and worsened; she was next seen at Episcopal Eye and Ear Hospital in June, 1956, complaining of hoarseness and obstructive dyspnea at the nasal and laryngeal level. Chest and neck x-rays at this time showed "hilar adenopathy consistent with sarcoidosis; lung fields clear . . . definite increase in soft tissue shadow in both laryngeal vestibules and sub-glottic area." Her only medication was copious amounts of vasoconstricting nose drops. A tracheotomy was refused until it became mandatory on August 13, 1956. A laryngeal biopsy showed only thickened epithelium with chronic underlying inflammation. The patient's breathing gradually improved, and she was decannulated on Nov. 9, 1956. Severe obstructive dyspnea recurred on Nov. 12, 1956, at which time she came under my care. A second tracheotomy was performed and the patient was given prednisone after an attempt was made to rule out tuberculosis. A tuberculin test was negative (PPD 1 and 2). The A/G ratio was 1.2/1. The patient weighed 180 lb. and had none of the classical symptoms of tuberculosis except cough (no hemoptysis, weight loss, night sweats, or known exposure). Another biopsy from the right false cord was reported as "granulomatous lesion, consistent with but not diagnostic of tuberculosis." The patient was given 30 mg. of prednisone in divided daily doses, and on Dec. 20, 1956, her tracheotomy tube was removed. After five days the dose was cut to 25 mg., and four days later to 20 mg. After three more days the dose was cut to 15 mg., but respiratory distress returned, and the dose was raised to 20 mg., at which level the patient was maintained for three months, taking 5 mg. four times a day. There was no difficulty during this interval, but despite marked sodium restriction, the patient gained 20 lb. During the fourth month of therapy the dosage was diminished to none. There were two episodes of dyspnea during this month, relieved by the injection of 40 units of corticotropin (Acthar) gel. No steroid therapy has been given since early April, 1957. The skin lesions improved on therapy, and a chest x-ray on May 2, 1957, showed only slight enlargement of glands in the left hilum. On Aug. 14, 1957, a direct laryngoscopy showed no localized lesions, and dilators through 26F were passed with ease. This patient was last seen on Jan. 16, 1958. Her weight has returned to 179 lb. She has had no difficulty in breathing since her therapy, except nasally. She has remained moderately hoarse and has a slight nonproductive

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cough at night only. In the last month she has developed some new skin lesions in the right lid. She is being referred for further therapy to the District of Columbia General Hospital, as she no longer has severe otolaryngologic symptoms.

Comment

Sarcoidosis is a protean disease which must be distinguished from histoplasmosis and tuberculosis. A few practitioners still maintain it is an atypical form of the latter and treat these patients accordingly. Steroid therapy has been much used lately; earlier treatments included x-ray irradiation, nitrogen mustard, calciferol, chloroquine, streptomycin and other antibiotics, urethan, and isoniazid.[1] The disease is usually benign, and spontaneous remissions occur. In most cases of sarcoidosis, laryngeal involvement is incidental and not a severe complaint. Israel et al.,[2] in reviewing 36 patients with sarcoidosis treated with cortisone, describe one with a laryngeal granuloma. Earlier papers by Shea[3] and Barley[4] review laryngeal sarcoidosis well, but were written in the presteroid era.

In conclusion, I feel the laryngologist, when confronted with an obstructive sarcoid lesion, should proceed with heavy corticosteroid therapy, taking care to rule out tuberculosis first. When the disease is less acute it can be referred to the internist, dermatologist, or chest physician. In aiding decannulation of other obstructive laryngeal inflammations, treatment with corticosteroids seems a likely extension of their use.

1150 Connecticut Ave. N. W. (6).

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Anomalies of the Middle Ear

JOHN F. TOLAN, M.D., and HESTON L. WILSON, M.D., Seattle

Increasing use of the stapes mobilization procedure has rapidly increased knowledge of variations in anatomy of the middle ear. Three such anomalies have been encountered by us and are here presented in detail.

Review of the literature reveals few reports of such anatomical variations. Francis Sooy [1] reported bilateral absence of the incus in a 16-year-old girl. The hearing loss was a conductive type with 50 db. loss on the right and 45 on the left. Excellent improvement was produced by the fenestration procedure.

Schuknecht and Trupiano [2] reported a case in which progressive hearing loss had occurred over a 12-year period. Bilateral conductive loss was found. Upon exploration of the middle ear on the left side the stapes was found ankylosed by a bridge of bone from the pyramidal eminence to the neck of the stapes. Upon removal of this bridge, marked improvement in hearing occurred.

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The following three cases were noted in which several interesting similarities were found. All three had unilateral hearing loss of long duration. The level of hearing loss in all ranged at about 50 db. level. In all the cases abnormalities of the incus were found.

CASE 1.—A man aged 45 was first seen in May, 1954. The primary complaint at that time was occasional mild dysphasia dating from hospitalization for tuberculosis in 1935. He also gave a history of hearing loss of many years' duration. He could not recall the date of onset. No history of otalgia or otorrhea was elicited. The family history was negative in regard to hearing loss. Laryngoscopy at that time revealed marked scarring and distortion of the upper portion of the epiglottis. Biopsy showed focal mucosal scarring and distortion. No tubercle bacilli could be found. Chest x-ray and sputum studies failed to reveal active disease. Tympanic membranes at this time were found within normal limits. Audiogram was as shown in Figure 1. Stapes mobilization was recommended at that time.

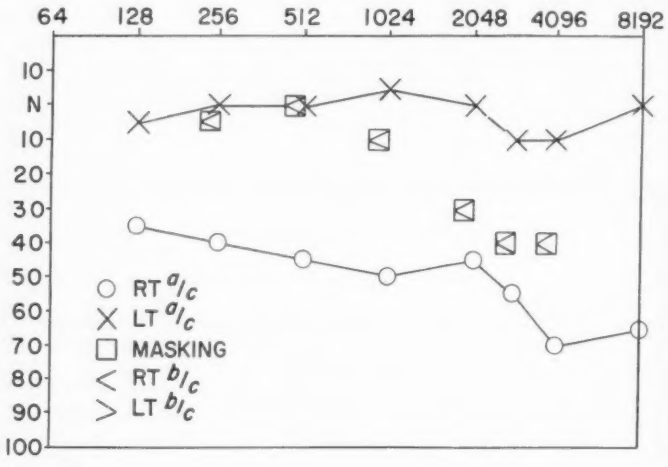

Fig. 1 (Case 1).—Preoperative audiogram.

The patient returned again in May, 1957, and on May 13 surgery was performed on the right ear. When the middle ear was entered, the stapes was

Fig. 2 (Case 1).—Showing approximately one-half of the long process of the incus replaced by a fibrous band.

found in normal position. Approximately one-half of the long process of the incus was replaced by a fibrous band (Fig. 2). This extended from the remnant of the incus to the head of the stapes. The stapes was freely mobile, and the stapedius muscle appeared within normal limits. No audiometric improvement occurred during the course of the surgery. Postoperative course was uneventful, and postoperative audiogram was unchanged as compared with the preoperative hearing studies.

Case 2.—A 49-year-old white man dated the onset of his hearing loss to a severe blow to the side of his face. The exact date could not be recalled, although it had occurred sometime in his early teens. Hearing loss had persisted in the left ear since that time. Otherwise the otolaryngological history was negative. No familial history of hearing loss.

When he was first seen on Jan. 17, 1957, both tympanic membranes were translucent, with no evidence of previous perforation. The remainder of the examination was within normal limits. The audiogram is presented in Figure 3.

On March 28, 1957, the middle ear was approached in the fashion advocated by Rosen. The chorda tympani was in a much lower position than would be expected. Most of the long process of the incus was absent. Search for the pyramidal eminence showed it to be in a normal position. A smooth mucosal surface was present over the eminence, and no muscle fibers could be discerned (Fig. 4).

In the region of the oval window, an outcropping of irregular bone was present. This was very irregular and failed to show evidence of any normal portion of the stapes. When this area was touched with a probe, the patient noted a definite sensation of vertigo. Hearing, however, was not improved. The tympanic membrane was then returned to its normal position. Postoperative course was uneventful, and audiogram one week later showed no change from the preoperative level.

Fenestration has been recommended to both the above patients.

Case 3.—A 20-year-old white woman was first seen in our department in August, 1957, stating, "I have had poor hearing in my right ear since early childhood." She admitted to having episodes of otitis media as a youngster, usually with upper respiratory infections and involving for the most

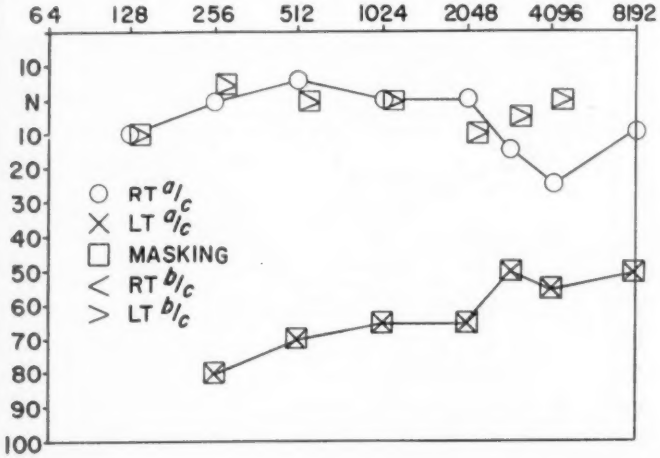

Fig. 3 (Case 2).—Preoperative audiogram.

Fig. 4 (Case 2).—Middle ear at operation.

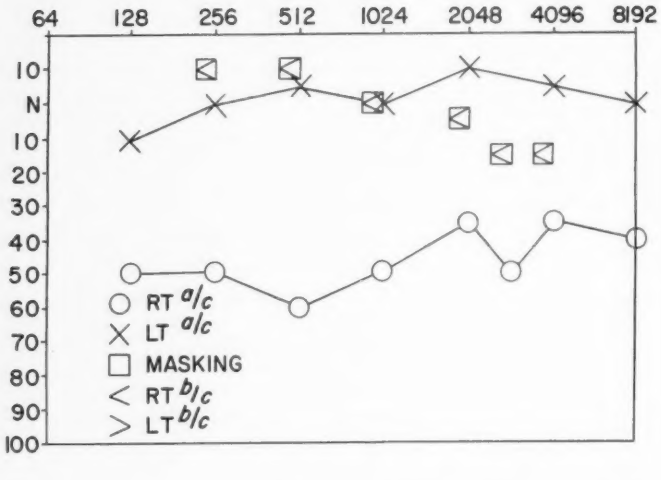

Fig. 5A (Case 3).—Preoperative audiogram.

Fig. 5B (Case 3).—Audiogram three weeks after operation.

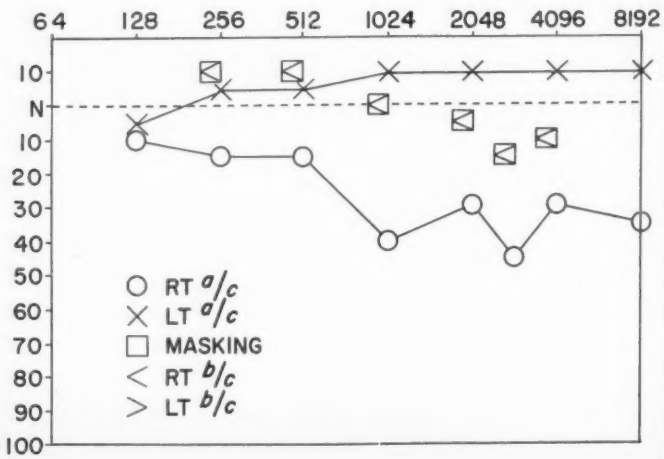

Fig. 6 (Case 3).—Showing incus of insufficient length to articulate with the head of the stapes.

part the right ear. She also stated that she had no hearing problem in the left ear.

Our examination revealed both tympanic membranes to be intact, the right retracted and slightly scarred. The Eustachian tubes inflated easily. There were no other significant ear, nose, and throat findings. Audiometric studies showed normal air conduction and bone conduction in the left ear, but 50-60 db. loss in the conversational range in the right ear for air conduction, with normal bone conduction (Fig. 5).

On Sept. 25, 1957, the usual stapes mobilization technique was used in approaching the middle ear. After the skin flap and drum had been displaced anteriorly, we noted a very interesting phenomenon in the middle ear. There was a gap of approximately 2 mm. between the end of the long process of the incus and the head of the stapes. This represented a shortening of the incus, due either to previous infections or to congenital malformation. The free end of the long process was adherent to the promontory with a band of scar tissue. This was severed, freeing the long process. There was no displacement of the incus from its normal course to the stapes; it merely lacked sufficient length to articulate with the head of the stapes (Fig. 6). There was some fixation of the stapes but this was easily mobilized. After this was done we placed a piece of absorbable gelatin sponge (Gelfoam) between the free end of the long process of the incus and the head of the stapes. The flap was then relaxed sufficiently so that the tympanic membrane came in contact with the absorbable gelatin sponge, which in turn was in contact with the caput of the stapes.

Testing followed the replacement of the flap, and we noted a marked increase in the low frequencies, including the 128 to 500 frequencies, with very little change in the middle and high frequency ranges. This she has maintained some four to five weeks after surgery.

We anticipate doing a fenestration on this girl but found this to be a most interesting anomaly, most likely on a congenital basis.

1118 Ninth Ave. (1).

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Clinical Notes, New Instruments and Techniques

A Simple Quantitative Caloric Test

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In a recent article, Hitschler[2] described a simple caloric test in which he used water at a constant temperature (36-37 F) for a definite period of time (5 seconds). He stated that the time during which the water is in contact with the eardrum is the important factor, not the amount of water, and that severe reactions are uncommon in this procedure.

For the past 10 years we have been employing at this hospital a form of caloric testing very similar to that just described, but which we believe also is quantitative and thereby will show slight changes during subsequent testing of the same patient. In 1949 streptomycin was introduced for the treatment of tuberculosis at this institution. In order to detect early evidence of toxicity as far as the eighth nerve was concerned, each patient, before treatment was started, received a pure-tone audiometric examination and a caloric test. Subsequently, each patient was retested at intervals of four months or earlier if he complained of decreased hearing or dizziness. In this way, severe damage to the eighth nerve apparatus could be prevented by stopping therapy in time.

The caloric test which has been used consists in placing a speculum in the external auditory canal to expose the drum membrane, any cerumen having been removed prior to audiometric examination. The head was turned to place the horizontal semicircular canal being tested in the vertical plane, and the presence of spontaneous nystagmus was determined. If this was found, testing was not performed. The head was then turned so that the ear being tested was uppermost. Using a 10 cc. Luer-Lok syringe with a blunt 20-gauge needle, 3 cc. of water from a mixture of ice cubes and water (temperature 33 F) in a container were introduced into the external auditory canal and directed against the drum membrane. A stop watch was started at the moment the plunger of the syringe was depressed. The water was left in the canal for 9 seconds and then the head was turned to the same side and the water allowed to run out. The head was then turned so that the horizontal semicircular canal being tested was in the vertical plane, and the time of onset of nystagmus was observed by having the patient fix on a finger held in front of his eyes. Nystagmus usually began 15 to 20 seconds after the beginning of the introduction of water and persisted for 60 to 100 seconds. The subjective complaint of dizziness varied in each patient, but in none was there nausea or vomiting. After the cessation of nystagmus, the canal was dried with a cotton applicator, and after an interval of two or three minutes the procedure was repeated on the other ear.

The above test has been employed 4008 times on 1082 patients. In retesting, it was noted that if no symptoms of disturbance in the vestibular apparatus existed, the onset of nystagmus was always at 16 seconds (plus or minus 0.2 sec.) and the duration varied on repeated examination from 2 to 10 seconds from the initial finding. In early evidence of toxicity, the onset of nystagmus was less than 15 seconds and the duration was over 100 seconds, while in patients who had damage to the vestibular apparatus, the onset of nystagmus was over 20 seconds and the nystagmus would last less than 60 seconds and in extreme cases no nystagmus could be produced. In patients who showed beginning toxicity stopping of the medication resulted in the caloric findings returning to their pretreatment values.

The above test is a variation of the Atkinson[1] modification of the minimal method of Kobrak. It differs in that 3 cc. of ice water are used and the ear is emptied of the water before the onset of nystagmus. It was found that using 1 cc. of water did not produce nystagmus in many patients and that 3 cc. seemed to be the least amount which would consistently produce nystagmus in normal subjects. Also, it was observed that if the ice water were left in the ear until the onset of nystagmus, the patient would complain of marked vertigo and frequently would have nausea and vomiting, and this would not occur if the water were emptied after 9 seconds.

Summary

A simple quantitative caloric test has been described. It is felt that this test gives results which

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From the Veterans' Administration Hospital.

are equally as good as the minimal and maximal tests which have been described in the literature. When the test is repeated on a patient, disturbances in the vestibular apparatus are noted readily. The test also has the advantage of producing minimal discomfort and side-reactions.

Veterans' Administration Hospital.

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News and Comment

ANNOUNCEMENTS

American Rhinologic Society Meeting.—The American Rhinologic Society will hold its Annual Program Meeting in Chicago at the Palmer House, Oct. 17 and 18, 1958.

The program will stress Nasal Physiology, with less emphasis on some other aspects of reconstructive surgery. Eight eminent men in this field will give papers at this meeting.

French Congress of Stomatology.—The 16th French Congress of Stomatology will be held in the first half of October, 1959, in Paris. The President is Prof. Étienne Cadenat, Toulouse, and the Secretary General is Dr. Roger Bataille, 43 Rue de la Chaussée D'Antin, Paris, France.

Two subjects have been selected, as follows:

1. The Traumatic Lesions of the Median Part of the Face with Regard to Traffic Accidents (Mechanism, Associated Lesions, and Treatment).
2. Allergic Manifestations in Stomatology.

Two questions have been put up for discussion.

1. The Height of the Lower Part of the Face in Orthodontics, Prosthesis, or Surgical Dentistry.
2. Accidental Traumatic Lesions of the Superior Incisors.

Progress in Otolaryngology

Bronchoesophagology

Summaries of the Bibliographic Material Available for 1956

F. JOHNSON PUTNEY, M.D., Philadelphia

The majority of the contributions in bronchoesophagology in 1956 have developed in fields other than those connected with otolaryngology. Basic research has been carried out in the allied specialties, but the lack of original work among bronchoesophagologists is deplored, and even clinical observations among bronchoesophagologists were few in the year reviewed.

Experimental Studies

Hilding [1] demonstrated that the mucous blanket in the tracheobronchial tree may be made to impinge upon and accumulate at an artificially deciliated island just as upon an obstruction. The impingement may remain for hours on such an area while ciliary action and streaming of mucous continues in the surrounding areas.

Hilding [2] also demonstrated that the carina divided the ciliary streams from the two main bronchi in such a way that there was a special concentration of flow on the anterior and posterior walls of the trachea. Both of these were directed upward to the larynx with some tendency to spread.

Elimination and transport of mucus in the lung was studied in animals by Huppler and his associates.[3] It was concluded that when the tracheobronchial tree was completely occluded in the absence of infection secretions of the respiratory tract were removed in the lobule of the lung by the process of phagocytosis. When the secretions were retained in an isolated segment of the bronchus, a bronchogenic cyst was not produced, and the most likely explanation for this seemed to be that the mucous glands and goblet cells secreted until the endobronchial pressure became so great that the glands could no longer continue to secrete against ahe pressure within the bronchial lumen.

The closing mechanism between the esophagus and the stomach was investigated in dogs by Nauta.[4] The esophageal wall itself was found to possess no mechanism of preventing regurgitation. The closure between the esophagus and stomach was found to be valve-like, owing to the oblique inlet of the esophagus into the stomach. The outside of the inlet was supported by the diaphragm, while the inside was supported by the oblique fibers of the stomach. The water-tight closure of the stomach was produced by a rosette of gastric mucosal folds, and no single mucosal valve or fold mechanism was demonstrable.

Friesen and Miller [5] found that the continence of the esophagogastric junction of the dog was dependent primarily upon the intrinsic esophagogastric sphincter and was in no way related to the normal diaphragmatic attachments. Reflux esophagitis did not develop in dogs with experimental hiatal hernia unless the degree of gastric obstruction at the level of the diaphragm was great and rendered the sphincter above the obstruction incompetent.

The esophagogastric sphincter in dogs was found by Friesen and Miller [6] to protect the esophagus from the development of esophagitis which regularly occurs after esophagogastrostomy.

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The results of experiments by Braasch and Ellis [7] clearly indicated that when the esophagogastric junction was destroyed esophageal reflux occurred as evidenced by esophagitis. There was no marked difference in the postoperative incidence of esophagitis in dogs, in one group of which the new esophagogastric junction was placed in the thorax and in the other it remained in the abdomen. It was concluded that the diaphragm itself was not the major factor responsible for gastroesophageal continence and that a physiologic sphincter of undefined nature was present in the region of the esophagogastric junction.

Anesthesia

Discussing the problem of endoscopic topical anesthesia, Himalstein [8] pointed out that safety would be achieved by administering slowly the least amount of the least toxic drug in the most dilute solution compatible with efficient anesthesia.

Reviewing 100 consecutive bronchoscopies with the use of topical cocaine anesthesia, Tella and Weisel [9] reported seven minor and two severe anesthetic reactions. The minor reactions consisted of syncopal attacks and the severe reactions consisted of convulsions. Cocaine produced fewer toxic reactions than tetracaine.

Hughes and his co-workers [10] employed a topical anesthetic agent (Dyclone) which was potent, fast, nonirritating, and nonsensitizing in 569 peroral endoscopic procedures. Approximately 7 cc. of a 0.5% or 1% solution was used in applications to the pharynx and an additional 10 cc. of 0.5% solution was injected directly into the larynx and trachea. The time required for good anesthesia was about 6 minutes and the anesthetic generally lasted from 30 to 45 minutes.

Bronchography

The combined diagnostic procedure of bronchography and bronchoscopy was employed by Kalinowski and Lloyd [11] in 100 consecutive cases. After the bronchoscopy was completed the bronchoscope was withdrawn until the tip was positioned about ½ in. below the carina. The exposed main bronchus was sprayed with an anesthetic solution, and 20 ml. of the opaque medium was injected slowly into the exposed bronchus. The bronchoscope was then removed and the patient positioned on the roentgen table for the taking of films after all the bronchi had been filled by utilizing the lateral position.

Domm and his co-workers [12] were unable to find an aqueous contrast medium that met the requirements of safety, anesthesiologic simplicity, and fluoroscopic control. Dionosil oily proved to be the agent best suited for the majority of procedures, but selection of the medium best suited to the diagnostic problem, the local situation, and the examiners' own experience was necessary to obtain optimum results.

Nice and Azad [13] cited their experience with Dionosil as a contrast medium in 74 bronchographic examinations and found many advantages and no disadvantages to its use. The examinations were unhurried, good diagnostic filling was obtained, with no unusual irritability and little tendency for alveolar filling. Only a trace of the opaque substance was present three days after bronchography.

Oily Dionosil was found by Boren and Miller [14] to be a safe, well-tolerated bronchographic medium when used in patients with nontuberculous lesions or with controlled, stable, pulmonary tuberculous lesions. The oily preparation was more satisfactory than the aqueous solution and the quality of the films was equal to that obtained by iodized oil. No complications were encountered and clearing of the medium occurred within 24 hours.

Congenital Lesions

A case of congenital subglottic laryngeal stenosis in a 10-year-old boy producing stridor and requiring surgical treatment was reported by Bateman and Carruthers.[15]

Four cases of esophagobronchial fistula in adults were presented by Dupre and his associates.[16] While one case represented a congenital abnormality, the others were late complications of severe infectious processes in bronchiectatic lungs. The acquired communications resulted from extension of the infectious process from the depth of a pulmonary lobe through the contiguous mediastinal space into the wall of the esophagus.

A case of esophageal stenosis at the level of the cardia associated with a congenitally short esophagus in a 7-week-old infant was presented by Vargas and his associates.[17] Esophagoscopy revealed a tight stenosis 14 cm. from the upper alveolar margin through which a filiform bougie could not be passed.

Bronchial Trauma

In discussing fractures of the first rib Holmes and Netterville[18] reported an esophageal diverticulum with tracheoesophageal fistula diagnosed six months after the injury. In another case fracture of both first ribs resulted in complete severance and occlusion of the left main stem bronchus 3 cm. beyond the carina.

Bronchiolitis

Bronchoscopic aspiration was considered an important part of the management of severe cases of bronchiolitis and was carried out in 33 of 727 patients by Fearon and Bain.[19] Difficulty was encountered in establishing strict criteria for bronchoscopic aspiration in these cases. No problem was encountered in the group of patients admitted in a moribund condition with cyanosis and gasping and in those who suddenly became worse after hours or days of medical treatment in which death would certainly ensue unless lifesaving measures were instituted promptly. The decision was more difficult in the patients who appeared to be getting progressively worse after several hours of medical treatment, and in this group the authors were guided by the age of the patient, the general physical condition, pulse and respiratory rate, presence of cyanosis, air hunger as evidenced by restlessness, sleeplessness and whimpering, and degree of tiredness. Bronchoscopy in these patients was rarely an elective procedure but usually an emergency when the patient was in marked respiratory distress and a state of collapse. After introduction of the bronchoscope the secretion was invariably found to be viscous, tenacious, and greenish in color with a semisolid consistency. The mucosa of the tracheobronchial tree was inflamed and swollen to a variable degree throughout and marked bronchospasm was usually evident. Bronchoscopy had to be repeated on three of the patients in whom the same clinical picture recurred in 24 to 48 hours, but improvement again occurred with the patients going on to complete recovery. Since the secretion was too thick and tenacious to be coughed out by the acutely ill and weakened infant, aspiration through the bronchoscope eliminated this factor in the illness. The administration of oxygen in a high concentration through the bronchoscope was a temporary adjunct to the therapy.

Aerosol Therapy

Pancreatic dornase aerosol was employed by Cliffton[20] in 104 patients, 65 receiving the inhalations before bronchoscopy and 39 receiving inhalations for the treatment of pulmonary disease. No severe reactions and only a few minor complications developed. Its prebronchoscopic use was designed to increase the positive cytologic results in bronchogenic carcinoma. In acute pulmonary disease with thick tenacious mucus the response was rapid and satisfactory, while in chronic disease the response was slower but remarkably good. The enzyme was considered particularly useful in postoperative thoracic surgical patients and post-traumatic patients with thoracic injuries.

Foreign Bodies in the Airway

Sheehy[21] removed a large tracheal foreign body measuring 5 by 4 by 3 cm. from a patient who aspirated a large piece of

meat. Respiratory difficulty was relieved immediately after removal of the foreign body.

Gregg [22] reported an instance where the tip of the flexible bronchoscopic aspirating tube was broken off in the right lower lobe bronchus during bronchoscopy. The missing tip was located easily in the lumen of the medial basal segment and removed with foreign-body forceps without difficulty. Prevention of this complication by careful handling and critical appraisal of instruments immediately prior to their use was advocated.

Bronchiectasis

In a study of 14 cases of bronchiectasis caused by bronchial obstruction secondary to a foreign body Cooley and his associates [23] found the prognosis after pulmonary resection was excellent. In this group the results were better than those obtained in patients with primary bronchiectasis, and there was no postoperative atelectasis, although the incidence of postoperative empyema was greater in the foreign-body bronchiectasis cases. The latter difference was attributed to the increase in obstructive pneumonitis in the presence of foreign-body bronchiectasis. Basic pathogenic and physiologic differences probably exist in foreign-body bronchiectasis in distinction to primary bronchiectasis. Early bronchoscopic removal of foreign bodies is necessary to prevent bronchiectasis whereas surgical resection is the treatment of choice when the condition has already developed.

Broncholithiasis

In a review of *27* cases of broncholithiasis Groves and Effler [24] found hemoptysis and cough the chief symptoms. Three cases had endoscopic diagnosis only while in three others endoscopic removal was accomplished. Although the incidence of clinically significant broncholithiasis was low, aggressive therapy was advocated earlier in the disease.

Pulmonary Abscess

Ban [25] analysed 60 cases of lung abscess and found no relation to any operative procedure. The low incidence of lung abscess in females was noted. With the use of antibiotics in large doses in acute lung abscess a cure rate of about 80% was achieved. The residual bronchiectasis was usually symptomless and required no treatment.

Bronchial Tumor

Unusual endobronchial tumors were discovered in 14 patients by Donoghue and his associates.[26] These consisted of five cases of hamartoma, four of lipoma, four of fibroma, and one fibrosarcoma. Of the 14 tumors 10 were visible bronchoscopically but were indistinguishable from other endobronchial tumors without biopsy. Even though 10 tumors were bronchoscopically visible only 4 could be removed through the bronchoscope. Two instances of extrabronchial extension of the tumor were found among the lipomas. Of the four tumors removed through the bronchoscope two were hamartomas and two were fibromas. When a benign lesion was demonstrated and its size or bronchial attachment presented no excessive risk to the patient bronchoscopic removal was done. Frequently the tumor was found to be out of reach of the forceps or sufficient pulmonary damage had occurred so that surgical excision was advisable.

Paterson [27] described an endobronchial hamartoma in the left upper lobe visible bronchoscopically with a right-angle telescope as a smooth, pale, pink tumor.

Zeman [28] reported a bleeding tumor mass in the left upper portion of the trachea just below the vocal cords, which proved to be a carotid-body tumor on histologic examination. The mass was removed with cupped forceps and the base was cauterized. There was no recurrence after three years.

Bronchial Adenoma

Aceto and Chakravarty [29] reported a case of pulmonary tuberculosis with coexisting

bronchial adenoma. Since the diagnosis was established by bronchoscopy in spite of the assumption that the entire chest lesion was caused by tuberculosis and the existing positive sputum, it was felt that routine bronchoscopic examination should be performed in almost all patients with pulmonary tuberculosis.

Three cases of bronchial adenoma in children were reported by Sherman et al.[30] Two cases were treated by resection, and the third was untreated and was alive with symptoms three years later.

A case of adenoma of the bronchus in which metastasis appeared in the liver six years after excision of the original tumor by lobectomy was presented by Kincaid-Smith and Brossy.[31]

Bronchogenic Carcinoma

Neuman and his associates[32] reviewed 51 cases of primary bronchogenic carcinoma among patients under 40 years of age. Bronchoscopy was performed in 32 patients, and in 21 the diagnosis was made by visualization and biopsy of the lesion. In an additional nine patients malignant cells were found in the sputum or bronchial aspirates.

Davis and his co-workers[33] reported a series of 215 resected, noncalcified pulmonary nodules and pointed out the improbability of distinguishing the benign and malignant lesions by any means short of thoracotomy. In this series 47% were malignant, 37% being bronchial carcinomas. Bronchial carcinomas and granulomas comprised 75% of the total number of nodules. Of the granulomas studied 55% contained Histoplasma and 7% Coccidioides in contrast to 17% in which a tuberculous etiology was established. Minimal calcification within a solitary pulmonary nodule especially when there was no more than a fleck or two was unjustifiable grounds for assuming that the lesion was benign. It was concluded that every solitary noncalcified pulmonary nodule required thoracotomy, that in those with bronchial carcinoma the absence of symptoms and the promptness of surgery enhanced the chance for cure, and that careful histologic study of the granulomas revealed that the majority were fungal rather than tuberculous in origin.

Complications of Carcinoma

Hanckel and Hawk[34] reported that involvement of the food and air passages by carcinoma of the thyroid usually indicated a poor prognosis, although temporary palliation may be achieved by relief of obstruction and the use of irradiation therapy. In the well-differentiated follicular and papillary carcinomas, even though there was extensive invasion, the prognosis was surprisingly good, so treatment of the complications involving the air and food passageways should be carried out promptly and effectively. Local involvement of the food or air passages was demonstrated in six cases illustrating compression, recurrent laryngeal nerve involvement, attachment of the tumor to the trachea or esophagus, and actual invasion of the food or air passages by the thyroid carcinoma.

Swallowing Difficulties in the Newborn

Plarre[35] discussed gastroesophageal reflux in infancy and childhood and found the condition was more frequent than generally conceded. Since the pathological basis of the mucosal changes of this region are not clear both endoscopic and radiologic interpretation in the early stages of these clinical conditions is limited. In some of these young vomiting babies a planned study of endoscopic investigation controlled with biopsy could yield valuable data.

Morgan[36] reported a fatal case of neuromuscular incoordination of swallowing in a newborn probably secondary to birth trauma. Although the basis for treatment is unsatisfactory, it was suggested that an esophagoscope be passed in any case not improving in order to stretch the pharyngoesophageal sphincter.

Esophageal Pressure Measurements

Fyke and his co-workers [37] measured the deglutition pressures at the gastroesophageal junction and found a consistent band of elevated pressure about 3 cm. in width under resting conditions. This band extended from about 1 to 2 cm. below the hiatus to 1 to 2 cm. above the hiatus, and was obliterated on swallowing. The band of elevated pressure was interpreted as due to tonic contraction of the circular muscle fibers with fall in pressure on swallowing secondary to relaxation of these fibers. It was concluded that this zone represented a physiologic sphincter between the esophagus and stomach.

Diverticula of the Esophagus

Harrison [38] reported 15 cases of pharyngeal diverticula treated by esophagoscopic diathermy division of the septum between the pouch and esophagus. This method of treatment was advocated except in cases with fibrous stenosis of the upper esophagus and in certain cases below the level of the circular muscle fibers of the cricopharyngeus.

Baker [39] reviewed 100 cases of diverticula of the esophagus and found that hypopharyngeal and epiphrenic diverticula usually required surgery, whereas traction and thoracic diverticula usually did not cause symptoms and rarely required treatment. The hypopharyngeal and epiphrenic diverticula were symptomatic in all cases, whereas symptoms were present in only 27% of the traction diverticula.

Foreign Bodies in the Esophagus

Bateman and Carruthers [40] reported a case of a swallowed chicken bone which became impacted in the anterior wall of the cervical esophagus. The foreign body could neither be seen nor palpated endoscopically and external surgical removal was needed to extract the bone. Even with the neck open the foreign body was not visualized and only after introduction of an endoscope and palpation of the wall of the esophagus over the instrument was the bone located.

Bradbeer [41] reported an unusual course of a swallowed foreign body (bone) which perforated the pharynx back of the right aryepiglottic fold, passed in front of the pyriform fossa posterolateral to the cricoid cartilage, pierced the pretracheal fascia, and lodged in the thyroid lobe.

Esophageal Strictures

Of 29 patients seen in the acute stage of caustic burns of the esophagus Davis [42] performed esophagoscopy within two to four days after the initial injury and obtained accurate knowledge of the extent of the burn. There was no morbidity or mortality associated with this procedure done under general anesthesia, and in the three cases in which burns were seen and thought to be severe enough to cause stricture all of them subsequently developed strictures requiring treatment. Excellent results were obtained with a planned program of dilatation, even though multiple procedures were necessary, and excisional or replacement surgery was reserved for those cases not responding to dilatations.

One hundred forty-seven cases of corrosive strictures of the esophagus were treated by Fatti et al.[43] in six years with an over-all mortality rate of 9%. Dilatation was successful in 99 cases; 2 patients died from accidental injury at dilatation, and 2 others died from inhalation bronchopneumonia while the patients were under treatment by dilatation. Other complications of dilatation were acute dysphagia, hemorrhage, false passage, mediastinitis, and perforation into the pleura. Forty patients were treated by esophagogastrostomy after dilatation had failed, with a 20% mortality after operation.

Eleven patients with lye ingestion were treated by Ray and Morgan [44] with cortisone and antimicrobial therapy. No complications occurred, and only one case developed an esophageal stricture when therapy was delayed until the fourth day.

Esophageal Perforations

In instrumental perforations of the esophagus Benoit and Mayer [45] outlined a program of individualized treatment utilizing conservative measures in some instances and surgical procedures in others. Esophageal rest by withholding all oral intake, accompanied by large doses of penicillin and streptomycin, was begun in all cases. In lesions with minimal perforations seen within the first 12 hours of injury this management was all that was needed. In those lesions with a large perforation early operative treatment was performed within 24 hours, and the opening was sutured rather than employing a simple drainage procedure. In late cases with frank mediastinal suppuration drainage was all that could be accomplished.

In discussing the management of esophageal perforations, Bernatz [46] recommended primary suture of the rent in the esophagus to avoid late suppurative complications. In late cases surgical drainage of the mediastinum was lifesaving. Indicated supportive and antibiotic treatment were valuable adjuncts.

Benign Lesions of the Esophagus

Putney [47] pointed out that benign lesions of the lower esophagus in the aged were difficult to diagnose accurately because of confusion with diseases of other organs or malignancy in the esophagus itself. Both roentgen and esophagoscopic examination were necessary in most instances for diagnosis. In the aged, treatment may be directed toward relief of symptoms by conservative measures except when surgical excision and histologic study are needed for final diagnosis.

Two cases of lower esophageal web in adults were presented by Bugden and Delmonico,[48] who described a membranous weblike structure in the lower third of the esophagus. The patients complained of dysphagia and the abnormality was noted on the roentgenogram, but several esophagoscopic examinations were reported as normal. In view of the absence of esophagoscopic findings it is doubtful if the cases reported represented actual esophageal webs.

Esophageal Hiatal Hernia

Mobley and Christensen [49] studied 153 patients with esophageal hiatal hernia and found 21% were asymptomatic. The diagnosis was established by roentgenologic methods in 81%, esophagoscopy in 6%, and in the course of some unrelated abdominal operation in the remaining 13%. When the condition was suspected, esophagoscopy was performed after two negative roentgen examinations. Other indications for esophagoscopy included persistence of pain or dysphagia, exclusion of other disease processes in the esophagus, prior to surgical repair, unexplained anemia or hemorrhage in patients with known hiatal hernias, and suspected ulcerative esophagitis. Of the group over 97% were managed medically, and only 35% had recurrence of symptoms which occurred when treatment was neglected.

In discussing the clinical aspects of sliding hiatus hernia Sealy [50] considered the diagnosis dependent upon roentgenologic and esophagoscopic examinations. In 4 of the 51 cases the lesion was demonstrated by esophagoscopy and not by the first roentgen study, so that esophagoscopy was considered more accurate than roentgenologic examination in diagnosis. On esophagoscopy the most striking finding was a patulous esophagogastric junction, while other abnormalities noted were shortening of the esophagus and mucosal inflammation.

Of 50 pregnant patients with persistent gastrointestinal symptoms Gorbach and Reid [51] found hiatus hernia in 62%.

Hiatus hernia was found in 22% of 92 unselected gravid women by Sutherland et al [52] more frequently in the multigravida.

Thirty-one esophageal hiatus hernias were found in 360 pregnant women by Mixson and Woloshin,[53] who attributed the high incidence to progressive uterine enlarge-

ment. The hernia usually disappeared after delivery.

In reviewing the literature Wiley [54] found 11 cases of carcinoma of the cardia and lower esophagus within a hiatus hernia.

Achalasia

Kramer and his co-workers [55] considered cardiospasm to be a generalized esophageal disease rather than a localized one, caused by disorder of the parasympathetic innervation and displaying characteristic motor abnormalities. In cardiospasm, because of the deranged postganglionic parasympathetic plexus, neither the propulsive nor the spincteric mechanisms function properly and the vestibule which does not receive the impulses to induce relaxation remains continuously closed.

In discussing achalasia Texter et al.[56] pointed out the finding of degeneration of the ganglion cells of Auerbach's plexus in these patients and a generalized disorder of motility producing inability of the gastroesophageal vestibule to relax. The most important phase of treatment was adequate dilatation of the vestibule.

Palmer [57] used the transesophagoscopic biopsy-and-clip technique in six patients with achalasia to demonstrate that gastric mucosa lined the narrow segment (gastroesophageal vestibule) as far as the brink of the dilated esophagus.

Schindler [58] listed 84 cases of cardiospasm treated by brusque dilatation using the Starck metal dilator, reporting a cure in 80 of them. The diagnosis was made by roentgen examination and passage of a No. 44F. bougie, but no esophagoscopy was performed. The dilator was introduced into the stomach under the fluoroscope in a closed position, and after proper placement at the point of narrowing was forcibly opened against resistance. Two forms of cardiospasm were described, the usual one being obstruction extending from a few centimeters above the diaphragm to the cardia and the rare form in which the obstruction was situated at the cardia. There was no evidence that cardiospasm was a purely psychogenic disease.

Allison [59] stressed the importance of the preservation of the function of the cardia in benign lesions of the esophagus. A conservative approach was advocated in cardiospasm, hiatal hernia, lower esophageal web, and short esophageal stenosis. Especially in the surgical treatment of nonmalignant lesions in this locality there is a greater need for preservation or restoration of normal function. It was pointed out that cardiospasm suffered too long from radical surgical treatment and that either endoscopic dilatation or conservative myotomy was preferred in the treatment of this condition. While endoscopic dilatation by an inflatable balloon has an important place in the treatment of uncomplicated cardiospasm, it may also have certain disadvantages. It is not as effective as myotomy, is less certain in its immediate result, and may stretch the hiatus and the fascial connections of the cardia to such a degree that incompetence develops. If dilatation is performed successfully in a patient with cardiospasm associated with hiatal hernia, incompetence is inevitable and occurs likewise if the cardiospasm is complicated by prolapse of the cardia into the abdomen. Reflux of gastric juice into the dilated and inert esophagus of cardiospasm, no matter how it is produced, causes ulceration, bleeding, and at times stenosis for which resection may be necessary.

Potter and his associates [60] described carcinoma developing in a patient with achalasia. The need for periodic evaluation of patients with achalasia by esophagograms and esophagoscopy was stressed, particularly if bleeding or progressive dysphagia was present.

Williams [61] reported a case of carcinoma of the esophagus in a patient who had achalasia of the cardia.

Carcinoma of the Esophagus

Howarth [62] presented a case of double carcinoma of the esophagus with the tumors

located at the upper and lower portions of the esophagus. The patient had adult celiac disease, which was thought to be the predisposing cause.

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Books

BOOK REVIEWS

Les Tumeurs de l'amygdale et de la région vélopalatine. By A. Ennuyer, M.D., and J. P. Bataini, M.D. Price, not given. Pp. 536, with 150 figures and 91 tables. Masson & Cie, 120 boulevard Saint-Germain, Paris 6e, 1956.

This is a thorough, well-documented, clinical study of 1139 patients with tumors of the tonsil, soft and hard palate, and of the retro- and lateropharyngeal spaces. The authors discuss the bearing which the microscopic classification of the tumor, the sex and age of the patient, the location and extent of local and lymph-node involvement, technical details of radiotherapy, etc., have on the course of the disease and result of treatment. The follow-up of patients is good: They do not have an "indeterminate" group and all patients lost to follow-up or dead of intercurrent disease, are classified as failures.

The material consists of 534 tonsillar epitheliomas and 150 lymphosarcomas, 109 epitheliomas, 176 benign mixed tumors and 46 cylindromas of the hard and soft palate, and 124 tumors of the lateral pharyngeal and retropharyngeal spaces, half of which are neurilemmomas. Poorly differentiated epitheliomas and lymphosarcomas more frequently gave rise to lymph node metastases than did well-differentiated epitheliomas; cylindromas metastasized chiefly to the lungs. Lymph-node involvement secondary to tonsillar epitheliomas occurred in 75%, in those of the soft palate in 61%, and those of the hard palate 30%.

There was not much difference in the frequency of these tumors in the two sexes, except in tonsillar and palatal epitheliomas, where the relation of males to females was 10 to 1, and in lymphosarcomas of these regions where it was 6 to 4.

The over-all five-year cure rate after radiotherapy for tonsillar growths was 16% of 534 patients with epidermoid epithelioma and 35% of 150 patients with lymphosarcoma. However, while this low cure rate held true for tonsillar epitheliomas in 485 males, for 49 females it was 35%. Epitheliomas grossly limited to the tonsil and pillars did best; those extending to the soft palate did slightly worse, and poorest results were obtained in epitheliomas invading the base of the tongue. The presence of clinically involved lymph nodes in epitheliomas of the tonsil did not worsen prognosis significantly as long as the nodes were unilateral, movable, and isolated. Thus, 27% of 40 patients without clinically metastatic nodes were symptom-free at the end of five years; this cure rate fell to 22% of 73 patients with unilateral isolated clinically metastatic nodes. This differed sharply from the results in epitheliomas of the hard and soft palate; here the five-year symptom-free survival was 22% of 51 patients without clinically metastatic lymph nodes, but was only 7% of 57 patients irradiated with clinically metastatic nodes.

The authors recommend radiotherapy for treatment of epithelioma and lymphosarcoma and prefer surgery for mixed tumors and parapharyngeal growths. Operative treatment in the parapharyngeal group is delayed until indicated by symptoms, because of the slow natural course of the disease. In cylindromas, the results by either surgery or radiotherapy were so poor that the authors were uncertain as to whether to recommend one, the other, or both.

This book offers a great deal of reliable information on the behavior of tumors of the palatotonsillar region and their response to radiotherapy. This detailed information may be very helpful to otolaryngologists who have to deal clinically with these problems.

Directory of Otolaryngological Societies *

FOREIGN AND INTERNATIONAL

Canadian Otolaryngological Society
(Société Canadienne d'Otolaryngologie)

President: Dr. Robert T. Hayes, 42 Cobourg St., St. John, N. B.
Secretary: Dr. Donald M. MacRae, 34 Spring Garden Rd., Halifax, N. S.

Venezuela Otorhinolaryngology Society

President: Dr. Alfredo Celis Pérez.
Secretary: Dr. Jesús Miralles.

International Association of Allergology

President: Dr. Samuel M. Feinberg, 303 E. Chicago Ave., Chicago 11.
Secretary-General: Dr. José Quintero Fossas, Paseo 313, Vedado, Havana, Cuba.
Meeting: Third International Congress of Allergology.
Place: Paris. Time: Oct. 19-26, 1958.

International Bronchoesophagological Society

President: Dr. Jo Ono, Tokyo.
Secretary: Dr. Chevalier L. Jackson, 3401 N. Broad St., Philadelphia 40.
Meeting: Seventh International Congress of Bronchoesophagology.
Place: Kyoto, Japan. Time: Sept. 12-14, 1958.

International College of Surgeons, Section of Ophthalmology and Otolaryngology

President: Dr. E. G. Gill, 711 S. Jefferson St., Roanoke, Va.
Secretary-Treasurer: Dr. Louis Savitt, 3403 W. Lawrence Ave., Chicago 25.

International Congress of Audiology

General Secretary: Dr. H. C. Huizing, 182 Oostersingel, Groningen, Netherlands.
Place: Leyden, Netherlands.

International Course in Paedo-Audiology

General Secretary: Dr. H. C. Huizing, 182 Oostersingel, Groningen, Netherlands.
Place: Groningen, Netherlands.

Pan-American Association of Oto-Rhino-Laryngology and Broncho-Esophagology

President: Dr. José Gros, Havana, Cuba.
Secretary: Dr. Chevalier L. Jackson. 3401 N. Broad St., Philadelphia 40.
President of Congress: Prof. R. David de Sanson.
Secretary of Congress: Dr. Walter Benevides, Caixa Postal 2838, Rio de Janeiro.

NATIONAL

American Medical Association, Scientific Assembly, Section on Laryngology, Otology and Rhinology

Chairman: Dr. Victor R. Alfaro, Washington, D. C.
Secretary: Dr. Walter E. Heck, San Francisco.
Meeting: Atlantic City, June 8-12, 1959.

American Academy of Ophthalmology and Otolaryngology

President: Dr. LeRoy A. Schall, 243 Charles St., Boston.
Executive Secretary-Treasurer: Dr. William L. Benedict. 100-1st Ave. Bldg., Rochester, Minn.
Annual Meeting: Palmer House, Chicago, Oct. 12-17, 1958.

* Secretaries of societies are requested to furnish the information necessary to keep this list up to date.

American Board of Otolaryngology

President: Dr. Gordon D. Hoople, 1100 E. Genesee St., Syracuse 10, N. Y.
Secretary-Treasurer: Dr. Dean M. Lierle, University Hospitals, Iowa City.
Place: Palmer House, Chicago. Time: Oct. 12-17, 1958.

American Broncho-Esophagological Association

President: Dr. Francis W. Davison, Geisinger Memorial Hospital, Danville, Pa.
Secretary: Dr. F. Johnson Putney, 1712 Locust St., Philadelphia 3.
Place: The Homestead, Hot Springs, Va. Time: March 10-11, 1959.

American Laryngological Association

President: Dr. Fred W. Dixon, 1027 Rose Building, Cleveland.
Secretary: Dr. James H. Maxwell, University Hospital, Ann Arbor, Mich.
Place: The Homestead, Hot Springs, Va. Time: March 8-9, 1959.

American Laryngological, Rhinological and Otological Society, Inc.

President: Dr. Lawrence R. Boies, University Hospital, Minneapolis 14.
Secretary: Dr. C. Stewart Nash, 700 Medical Arts Bldg., Rochester 7, N. Y.
Place: The Homestead, Hot Springs, Va. Time: March, 1959.

SECTIONS:

Eastern.—Chairman: Dr. Chevalier L. Jackson, 3401 N. Broad St., Philadelphia 40.
Southern.—Chairman: Dr. Sam H. Sanders, 1089 Madison Ave., Memphis, Tenn.
Middle.—Chairman: Dr. Francis L. Lederer, 860 N. Lake Shore Drive, Chicago.
Western.—Chairman: Dr. Ben. R. Dysart, 960 E. Green St., Pasadena 1, Calif.

American Rhinologic Society

President: Dr. Russell I. Williams, 408 Hynds Bldg., Cheyenne, Wyo.
Secretary: Dr. Robert M. Hansen, 1735 N. Wheeler Ave., Portland, Ore.
Annual Clinical Session: Illinois Masonic Hospital, Chicago, October, 1958.
Annual Meeting: Chicago, October, 1958.

American Otological Society, Inc.

President: Dr. Moses H. Lurie, 483 Beacon St., Boston.
Secretary: Dr. Lawrence R. Boies, University Hospitals, Minneapolis 14.
Place: The Homestead, Hot Springs, Va. Time: 1959.

American Otorhinologic Society for Plastic Surgery, Inc.

President: Dr. Armand L. Caron, 36 Pleasant St., Worcester, Mass.
Secretary: Dr. Joseph G. Gilbert, 75 Barberry Lane, Roslyn Heights, N. Y.

American Society of Facial Plastic Surgery

President: Dr. Trent W. Smith, 327 E. State St., Columbus 15, Ohio.
Secretary: Dr. Samuel M. Bloom, 123 E. 83rd St., New York 28.

American Society of Ophthalmologic and Otolaryngologic Allergy

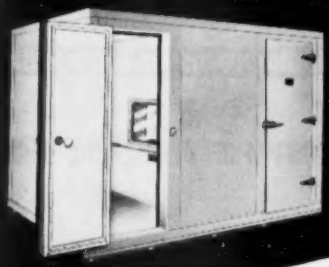
President: Dr. Joseph W. Hampsey, Grant Building, Pittsburgh 19.
Secretary-Treasurer: Dr. Daniel S. DeStio, 121 S. Highland Ave., Pittsburgh 6.
Place: Palmer House, Chicago. Time: Oct. 16-17, 1958.

Otosclerosis Study Group

President: Dr. Lawrence R. Boies, University Hospital, Minneapolis.
Secretary-Treasurer: Dr. Arthur L. Juers, 611 Brown Building, Louisville.
Place: Palmer House, Chicago. Time: Oct. 11, 1958.

Society of Military Otolaryngologists

President: Lt. Col. Stanley H. Bear (MC), USAF, Maxwell AFB, Ala.
Secretary-Treasurer: Capt. Maurice Schiff (MC), U. S. N., U. S. Naval Hospital, Oakland, Calif.
Annual Meeting: Palmer House, Chicago, Oct. 14, 1958.



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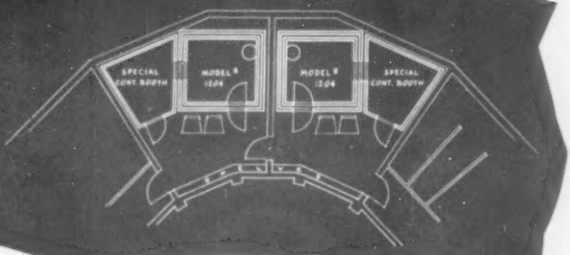

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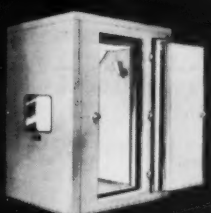

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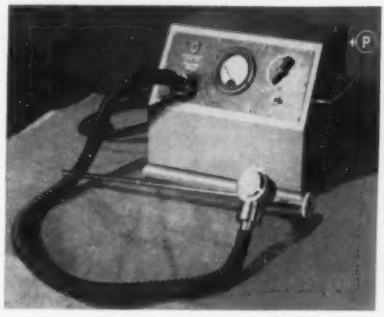
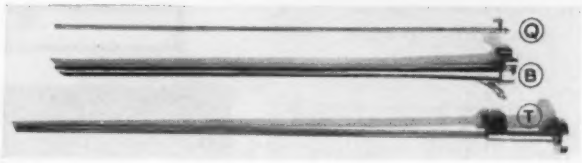


bronchoscope 9mm x 40cm (B)
quartz rod for illumination (Q)
forward-viewing telescope (T)
luminator (L)
power unit (P)



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References:

Jackson, C.L.: New Instrumentarium for Peroral Endoscopy and Endoscopic Photography. LARYNGOSCOPE, *67*:777, (Aug.) 1957.

Fourestier, M., Gladu, A., and Vulmiere, J.: LA PRESSE MEDICALE, *60*:1292, (Oct.) 1952.

Dubois De Montreynaud, J.M., Edwards, Roger, J., and Gladu, Amedé J.: LARYNGOSCOPE, *66*:637, (June) 1956. ———JOUR. BIOLOG. PHOTOG. ASSOC., *24*:45, (May) 1956.

The Jackson Fotobronchoscope is on display in Pilling's Philadelphia store and New York office. Write Philadelphia for further information and prices; send orders to Philadelphia.

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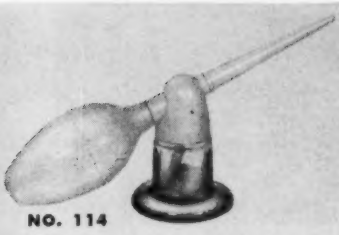

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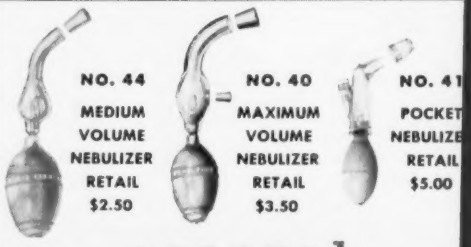

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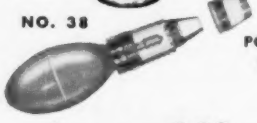

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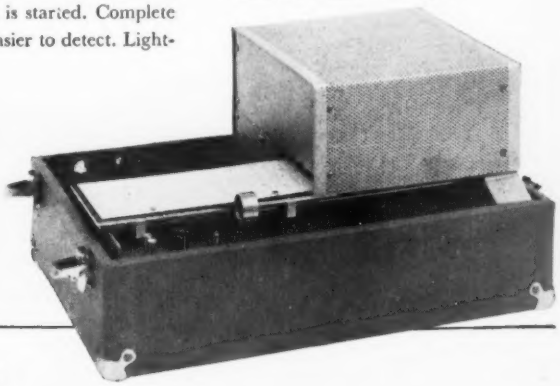

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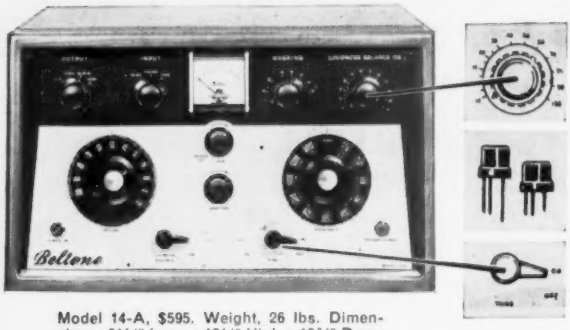

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